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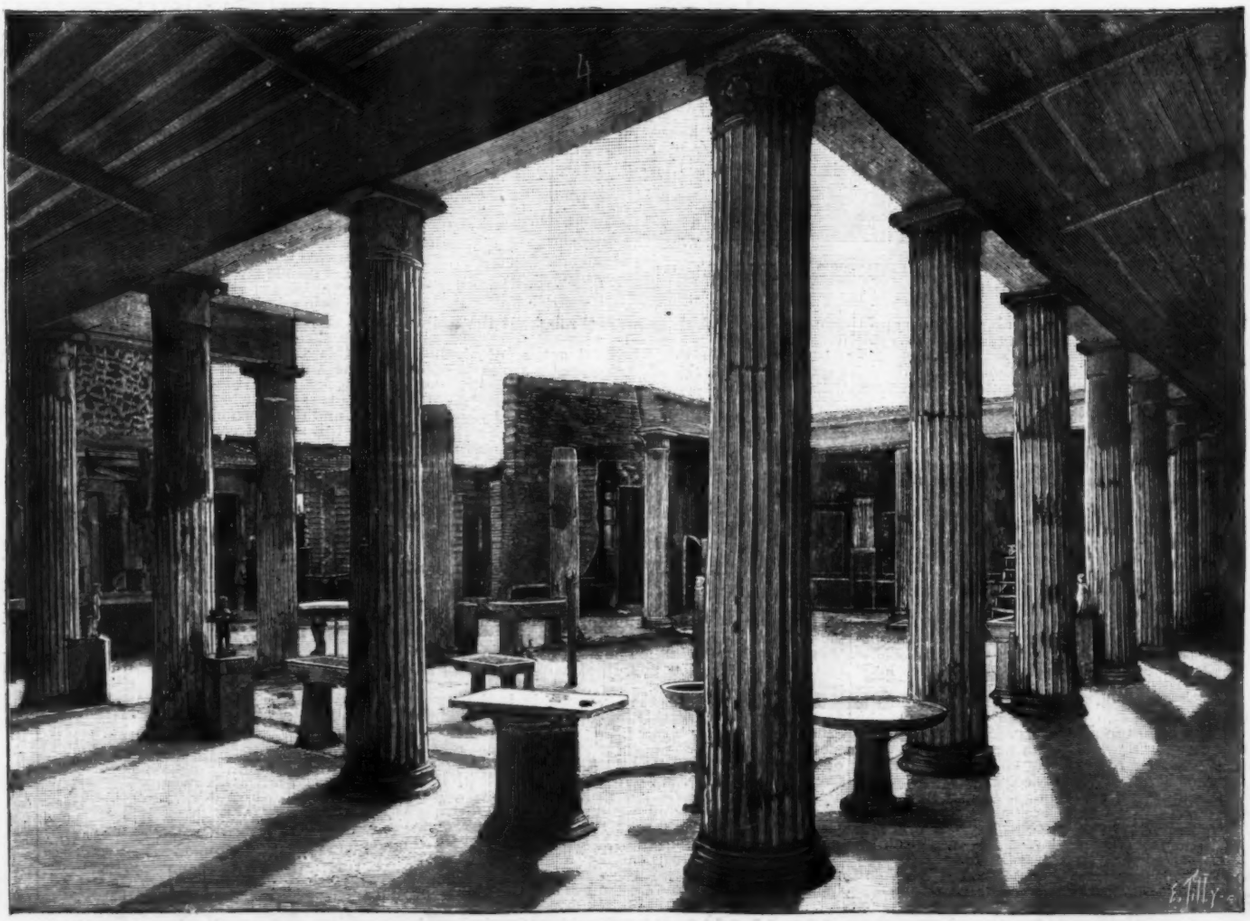
THE PUNISHMENT OF PENTHEUS.

THE INFANT HERCULES STRANGLING THE SERPENTS.



PERISTYLE OF THE HOUSE OF THE VETTII AT POMPEII.

THE MOST RECENT EXCAVATIONS AT POMPEII.

THE excavations at Pompeii have, for a long time, revealed nothing unexpected: commonplace houses, amphoræ, or some human remains, and nothing more. Can we be surprised at this? Were Versailles ever to disappear under the ashes and scoriæ of an unlooked for Vesuvius, how many ordinary dwellings of moneyed men would be exhumed by future archæologists for a single Trianon!

Finally, toward the end of December, while excavations were in progress in Region VI, at the north of the city, a vast hall whose walls were decorated with remarkable paintings was suddenly discovered. There was no doubt of the fact that it was the habitation of a Pompeiian of rank. The removal of the rubbish was conducted with extreme precaution and the entire house was soon laid bare.

The result exceeded all expectations. The abode of the Vettii had been unearthed. Does the name tell us nothing? Do we not know that the electoral placards that have remained intact, or nearly so, upon the walls upon which they were traced eighteen hundred years ago have taught us the names of the principal citizens that Pompeii numbered in the year 79? All the Vettii then occupied or aspired to high municipal functions. Considering what the price of votes was, the family must have been opulent.

The house of the Vettii, in fact, rivals the finest specimens of Roman habitations with which we are acquainted, not only in the importance of its artistic riches, but also in the perfect state of preservation of the latter.

Moreover, the new discoveries made at Pompeii offer so much the more interest in that the old methods have been abandoned. Statues, columns and panels decorated with paintings are no longer carried to the Naples museum (which has, any way, become too small), but all that the Pompeiian houses contain remains in place, and nothing is changed in the ancient arrangement.

THE PUNISHMENT OF DIRCE.

The particular value of each part is thus doubled by a general value. The Vettii might to-day live over again their life of days gone by in its accurately reconstructed setting. They would find again in the interior garden of their habitation even a trace of the groups of flowers and of the alleys that they were contemplating on the morning of the catastrophe. This house, which, instead of exhibiting the desolate aspect of those that have been emptied, is truly living, forms a small block whose principal entrance is situated upon the Vicolo Storto. According to the uniform architecture of the time, the atrium affords access to the peristyle. The portico is formed of eighteen Corinthian columns which support an entablature that is nearly intact. Upon pedestals between the columns stand statuttes representing Bacchus, Jupiter, Pallas, Venus and Cupids. Four marble tables rest upon feet of chimeras.

The decoration of all the rooms that surround the atrium bears witness to the wealth and taste of the owners of this sumptuous dwelling. The fresco paintings that we reproduce herewith ornament the walls of the two reception rooms situated at the north and south, at each extremity of the colonnade. They are of exceeding fineness and brilliancy. We have said that the directorship of the excavations, happily inspired, decided not to displace them. In order to preserve them from the action of the weather, they have been covered with glass over which roll curtains. The result of the discovery of the house of the Vettii has been to urge forward the excavations in the same direction. There is reason to believe that an entrance has just been made into a rich and elegant quarter of the buried city—the Plaine Monceau or Passy of Pompeii.—L'Illustration.

NEW PROCESS FOR KEEPING FRUIT FRESH.*

THE great difficulty experienced in preserving fruits in their natural state is such that the dealers who make the attempt of furnishing them out of season are compelled, on account of the heavy losses they sustain, to sell their goods at prices which render it impossible for the great majority of families to place fresh fruits on their tables during the winter months. The high prices which fresh fruits command on the city markets increase day by day from the time they are gathered, and have induced orchard and vine owners to run many risks in order to keep their fruits as long as possible before offering them for sale. And it is not surprising that no pains, efforts and sacrifices are spared to reach the coveted result when it is known that during these last years first class grapes sold from 2 to 4 francs (38·6 to 77·2 cents) per kilogramme (2·2 pounds) from September to November, that they were worth 8 francs ($1.53·4) and as much as 12 francs ($2.31·6) in February and March, and 14 francs ($2.70) in April and May.

These exorbitant prices show plainly how imperfect are yet the means employed for keeping fruits fresh, how few must be the successful efforts and how many the difficulties encountered. The solution of this question is, therefore, of great interest to all, and the result of the experiments made in the latter part of the year 1894, and lately reported to the Horticultural Society of Soissons by Mr. A. Petit, chief of the laboratory of horticultural researches at the National Horticultural School of Versailles, deserves the attention and consideration of fruit growers throughout the United States.

Impressed with the powerful action of alcoholic vapors on the mould which generally appears on the surface of fruits in a damp atmosphere, Mr. Petit noticed that pears and apples kept for several months in a surrounding saturated with vapors of water and alcohol, even were they at the beginning in a state of decay, showed no signs of mould; while fruits in every particular identically similar to the former, stored under the same conditions, but not exposed to the action of alcoholic vapors, were entirely covered with it.

Taking advantage of this observation, Mr. Petit applied the principle to the preservation of fruits in general, and most particularly to grapes, because, more than others, the latter are subject to mould. It was to be foreseen that grapes kept, from the day they are cut off the vines, in an atmosphere saturated with vapors of water and alcohol would, by the retarding of the sweating period, not only remain free from mould, but would even retain their natural aspect. Consequently, should the temperature be constant and low, the preservation could be maintained long and well.

On October 31, 1894—that is, very late in the season and at a very unfavorable time—Mr. Petit placed, with other fruits and a bottle filled with 100 cubic centimeters (61 cubic inches) of alcohol at 96°, some bunches of grapes known as "Chasselas de Fontainebleau," fresh from the vine, in a brick recipient in the form of a parallelopiped, cemented inside and closed as hermetically as possible by a common wooden door. In two similar recipients contiguous to the first, one of which was kept open and the other closed, but without alcohol, were stored similar fruits from the same trees and vines. The fruits were laid on wood shavings. The recipients were built in a very damp cellar, the temperature of which varied regularly from 10° to 8° C. (50° to 46½° F.) during the whole time the experiment lasted.

On November 20 the grapes placed in the recipient left open, and especially so those in the closed recipient without alcohol, were mostly rotten and covered with mould, and were immediately removed. In the recipient containing the bottle of alcohol the grapes were beautiful; on one bunch two grapes had turned brown, but were firm, full, and free of mould; they did not taste at all sour, thus differing essentially from mouldy grapes, especially those subject to Penicillium glaucum. The hygrometer in the recipient registered 98°. On December 7 the bunches of grapes in the recipient containing the alcohol had kept their fine aspect; on most of them, however, one or two grapes had turned brown and were in the same condition as those above referred to. On December 24 same results; on most of the bunches could be seen one or two grapes commencing to decay. At the end of nearly two months each bunch had lost but from two to four grapes each, and all were in a perfect state of preservation, the stalks being perfectly green and the grapes firm, full and savory, and having all the qualities of fresh cut grapes.

At the conclusion of the experiment, 28 cubic centimeters (17 cubic inches) of alcohol at 60° remained in the bottle out of the 100 cubic centimeters (61 cubic inches) at 96°, but as Mr. Petit remarks, the door of his recipient had not been built with great care and did not close hermetically; hence a useless consumption of alcohol.

The process offers many advantages. It is simple, easy of application and cheap, and, if adopted by our fruit growers, would allow them not only to hold their fine fruits until they can dispose of them at a fair price, but would also insure them handsome profits during the winter months.

* Henry P. Du Belict, Consul, in the United States Consular Report.

THE CULTIVATION OF VACANT CITY LOTS BY THE POOR

THE New York Association for Improving the Condition of the Poor, whose headquarters are at 105 East Twenty-second Street, has recently put in operation a local branch of the form of philanthropy known as the "City Lot Farm."

The experiment had its origin in the city of Detroit, and is to be credited to Mayor Pingree, who, in looking around during the summer of 1894 for some means of relieving the necessities of the large number of unemployed during the ensuing winter, hit upon the happy idea that vacant land in and near the city could be cultivated by the poor unemployed during the summer and subsistence for the winter thereby secured. A committee was appointed; 430 acres (8,760 city lots) were plowed, harrowed, and staked into lots of a quarter to half an acre each. Nine hundred and forty-five families received plots of land, seed and tools were furnished by the committee, and the seeding and planting were carried out under the direction of a volunteer superintendent. This novel form of philanthropy, which cost each member of the mayor's committee $3.60, enabled "nearly one thousand families to support themselves through the winter by their potato crops alone!"

Captain Gardener, United States Army, who had gained some experience in managing gardens for troops, took charge of the Detroit farms; having devoted his leave of absence to this work. Speaking of the work done last year (1895, this being the second year's experience with the farms), he says:

"This year we have met with remarkable success. We plowed and harrowed, and furnished seed for 1,546 parcels of land to as many heads of families, in all 455 acres, in one-third and one-fourth acre pieces. We harvested in potatoes alone, not counting other produce, over 60,000 bushels—an average of 40 bushels per family. The total crops were worth $30,000, at an expense of $4,900, out of an appropriation of $5,000 for that purpose.

"Our people were mostly shovel laborers, whose wages do not average a dollar a day and who have large families. It would do your heart good to see the gratitude and appreciation of these people. I tell you, Mr. Hall, it is the opportunity to help themselves that people want.

"Poor people are often as sensitive about being considered objects of charity as you or I would be, and as a rule they prefer to work for what they get, in preference to receiving things for nothing.

"We succeeded in getting our land for the purpose free this year. I predict that in a year or two the scheme will be universally adopted in the United States, for it appeals to common sense, and besides saving taxation, it teaches people to rely upon themselves and their own efforts. Direct giving makes paupers; this method constantly reduces their number."

The detailed figures of the results of this very successful scheme will be of great interest, and we give them in full:

EXPENSES FOR 1895.

Plowing	$1,530
Seed potatoes, 253,905 pounds	1,712
Other seed	252
Labor, hauling, staking land, etc.	714
Stationery, printing, Paris green, stakes, clerk hire, etc.	695
Total	$4,903

AMOUNT AND VALUE OF CROPS.

What was raised.	Amount.	Estimated value, March to August prices, when most of the crops were consumed.	Market value at present prices.
Potatoes	61,840 bu.	$40 196	$15,460.00
Beans	1,000 bu.	2,000	1,280.00
Turnips	3,000 bu.	1,000*	750.00
Beets	1,000 bu.	400*	250.00
Corn	400 bu.	180	116.00
Cabbage	4,608 bl.	250*	117.50
Squashes	400 hd.	30*	23.80
Pumpkins	800 hd.	.....	.....
Totals	67,240 bu. 5,568 hd.	$44,056	$17,997.30

* No market quotations; estimated.

Here, in the complete success of this common sense and thoroughly practical scheme, we see illustrated again the old truth that "charity begins at home." It is not necessary to organize schemes of colonization, for the purpose of removing the crowded poor from our cities to the country, when right at hand we have available such an effective and inexpensive charity as the City Lot Farm provides. In the solution of economic problems, especially those affecting the poor of our cities, the means are not necessarily far to seek. The practical way in which Mayor Pingree and Capt. Gardener attacked the question in Detroit, and the gratifying results which are shown in the above tabulation, prove that the simplest and most effective means are often those which lie nearest at hand.

THE SUPERINTENDENT'S ROUNDS.

In addition to the immediate benefits derived from the city lot farm, in the way of providing for the poor, or, rather, of enabling the poor to provide for themselves, this experiment is having another result, an indirect result which has great economic significance, and may in the future go far to counterbalance the inflow of population from the country to the cities. As evidence of this result we quote from a letter of Mr. F. B. Dickerson, superintendent of poor of Detroit:

"The city poor farm scheme, as operated in this city last year, was a great success. The poor, hard-working people see that upon a little patch of half an acre they can produce enough to half support themselves, and it sets them to thinking. They reason thus: 'If I can almost live on half an acre, I could make a comfortable living on a few acres,' and they begin to figure on getting into the country.

"In answer to a question asked me, I asserted that at least one hundred families had sought and found homes in the country as a direct result of their experience of last year. I fell far short of the mark, however, for one gentleman, the Hon. Joseph Waltz, of Waltz, Mich. (a small village in this county), writes: 'I see in the papers what you say about city farming, and think you are right in the matter, as twenty-five families from the city have located hereabouts.' If twenty-five families have located in the vicinity of one little village, the number of families who have located in other sections of the State must far exceed one hundred."

FAMILY WORK.

Of the multitudes which flock to the cities, attracted by the prospect of higher wages, the larger part, no doubt, realize their expectations, but there is and will always be a certain proportion of these who are ill suited to the rush and competition of city life. These, in common with the sickly and unfortunate, gravitate to the poorer and more densely settled slums. Their poverty is apt to be more their misfortune than their fault. It can readily be understood that the discovery that in the simple tilling of the soil there is a possibility of immediate subsistence, honorable and independent, would beget in such people a desire to leave their present hopeless and humiliating conditions, and seek a country life. The sense of possession, and, to a degree, the sense of creative power, are both gratified in the tilling of the soil—the natural and original labor of man. If the indirect result of this form of charity shall be the promotion of emigration, if not to the remote country, at least to the farther suburbs, where the garden plot is available, its benefits will be twofold, and the sphere of its usefulness will be immensely enlarged.

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FARM EDUCATION.

The New York branch of this work is under the management of a committee of the Association for Improving the Condition of the Poor, with Mr. R. F. Cutting as president. Their report states that there are 17,329 vacant lots (more than 1,400 acres) in this city below West One Hundred and Forty-fifth Street and the Harlem River; and experience has shown that if the vacant land be within three miles of the homes of the poor, they will use it. If the land be sterile, it can be enriched with the waste soil from excavations and with the refuse gathered from the city streets. The lessons of this philanthropic experiment are:

1. That a large number of the destitute are willing to work if they have the opportunity.
2. That a small piece of ground will furnish enough food to support a family through the winter.
3. That "the needy are thereby assisted without creating the demoralization in the habits of the people that gratuitous help always entails."
4. That in this way the continuous inflow into the cities may be in some degree compensated. Among other cities, outside of Detroit and New York, which have proved the good results of the vacant lot scheme, may be mentioned Buffalo, N. Y., Omaha, Neb., and Seattle, on the Pacific coast. In each case the poor have shown a ready and high appreciation of this effort to help those who will help themselves. The expenses of the New York society were $5,000, and $9,000 were realized from the sale of crops.

THE STATISTICS OF WAGES AND THE COST OF LIVING.*

AN examination of many hundreds of British, Continental, and American statistical works shows that until quite recently statements of wages have been expressed in a very crude and unscientific form. Such a study brings home the conviction that the difficulty of tabulating statistics of wages, in such a form as to clearly bring out the most valuable features involved, is as great as, if not greater than, that of collecting the original statistics from which the tabulation is drawn up.

The old form of statement of wages, as made use of by Dr. Thorold Rogers and others, was simple enough; but when social and economic science came in, with its demand for something more detailed than a mere statement of rates of wage paid, the work was much complicated; as for instance, when it was determined to record the number of hours of labor along with the average amount of wages paid in each trade. By way of illustration Mr. Wright quoted the case of Prof. Rogers, who could get no further than the mere statement for instance that a head mason got 4s for nine months of the year and the others 3s. 4d. for ten months. The reports of the British Board of Trade are carefully prepared and very valuable; and yet an examination of these, for the fifty years prior to 1860, shows that the statements during this period are not any more elaborate than those compiled centuries ago—that is to say, until very recent years there has been no attempt to show the number of persons receiving a particular wage, or a given rate.

Average earnings in the United States in the manufacturing and mechanical industries:

Census of	1850,	average	yearly	wage = $247.38
"	1860,	"	"	" 288.94
"	1870,	"	"	" 302.08
"	1880,	"	"	" 346 91
"	1890,	"	"	" 444.83

The above result is obtained by dividing the total amount of wages paid by the total number of wage earners. The result is of but limited value. It does not tell us for instance what number of people in 1890 actually received $444 83, or what proportion earned more, and what less. It may have been that the greater proportion earned a much smaller sum, and that the average was raised by the exceedingly high wages paid to a limited number. Statisticians are not satisfied unless they can give the classification of wages in detail. They do not consider that the mere statement of an average is sufficient, nor even the statement of the highest and the lowest wage with an average. The scientific method requires to know how many persons in a given occupation are in receipt of wages above and how many below a given average.

The subjoined table, which relates to the wages paid in the cotton industry in a particular locality, shows the modern method of presenting statistics of wages.

It will be seen at once from this table that, out of the 22,015 males covered by it, 6,298 received less than $5 per week; and that out of 26,163 females, nearly one-half were paid less than $5 per week. The concentration of labor at any point is thus easily ascertained. Under such a method all the industries of a State or of a whole country can be grouped and graded as to wages.

Some statisticians are content to secure the highest and the lowest wage paid in an establishment, add the two together and divide by two, in this way securing, as they suppose, an average. Mr. Wright described this method as being "exceedingly vicious, because one man may obtain a very high wage, which would overcome the influence on the average of a large number of persons receiving a low wage."

Many of the difficulties which occur in gathering the original data for wage showings are inherent in the conditions of industry. A man will sometimes work at more than one occupation during a given period. Cases, indeed, often occur where a man will be engaged in several different occupations within a year. Even if he remain at one occupation, he may be promoted to a higher rate of pay, each advancing rate representing higher skill or larger industry and attention. Pieceworkers are also the cause of many of the complications in wage statistics. The payrolls of a

*The seventh and closing lecture in the special course on Social and Industrial Statistics, by Carroll D. Wright, United States Commissioner of Labor, at the School of Social Economics, Union Square, New York. Abstract prepared for the SCIENTIFIC AMERICAN by J. B. Walker.

Classification of Weekly Wage.	Number of Persons Receiving Specified Wage.		Percentages.		Both Sexes.	Percentages.
	Males.	Females.	Males.	Females.		
Under $5	6,298	13,004	28·61	49·70	19,302	40·06
$5 but under $6	3,186	6,264	14·47	23·94	9,450	19·61
6 " " 7	2,956	4,177	13·43	15·97	7,133	14·81
7 " " 8	2,905	1,979	13·20	7·56	4,884	10·14
8 " " 9	1,945	488	8·83	1·86	2,433	5·05
9 " " 10	1,741	148	7·91	0·57	1,889	3·92
10 " " 12	1,361	52	6·19	0.20	1,415	2·94
12 " " 15	769	13	3·49	0.05	782	1·62
15 " " 20	577	23	2·62	0.09	600	1·25
20 " "	275	15	1·25	0 06	290	0·60
Totals	22,015	26,163	100·00	100 00	48,178	100 00

works will often show only the amounts paid the workmen, no record being made of the time or of the number of pieces of work which the pay represents. The lecturer instanced the case of a coal mine, where the books may show only the successive dates at which the tons of coal mined were credited to the workmen. The miner may have worked all or only part of the time included between these dates. The output with which he is credited may represent his own labor only, or that of himself and his own half grown son or other helper. It will be thus readily seen that it is at all times difficult and often impossible to ascertain the time of a pieceworker, and yet the time is an absolutely essential element in determining wages. A further difficulty is found in the fact that certain important employes work in gangs, crews, turns, shops, etc., different industries having different terms. The method of payment in such cases is liable to be as various as the terms themselves, and it is not universally the same in any given industry.

Mr. Wright drew a distinction between nominal wages and real wages. Nominal wages are the actual cash payments made to employes, and in considering their amount no account is taken of the purchasing power of money. Real wages can be determined only by ascertaining the price of articles or the purchasing power of the employe's wage. This is best done by taking the prices of articles entering into an individual's consumption at certain specified periods and calculating how much a given amount of money will purchase at these periods. Mr. Wright considered that this method was simpler, more common sense and less theoretical than the European method, with all its complication of piece statistics, weights, index numbers, etc. "What one dollar will buy in flour or in any other commodity at different periods tests the question of real wages in a simple and effective manner."

COST OF LIVING
(expressed in percentages of income).

In the United States.	Income $600 to $700.	Income $800 to $900.	Income $1,000.
	Per cent.	Per cent.	Per cent.
Rent consumes.	15·53	16·09	15·12
Fuel "	4·98	4·39	3·75
Clothing "	15·86	15·09	17·53
Food "	41·18	38 09	34·75
In Europe.			
Rent consumes.	9·43	10·07	....
Fuel "	3·52	2·98	....
Clothing "	15 69	18·04	....
Food "	45·54	46·24	....

The above figures, which are percentages of the stated incomes, show that the greater the income, the less is the percentage of outlay.

In concluding his course of lectures, Mr. Wright stated that he had tried to avoid leading his audiences into elaborate analytical discussions. His aim had rather been to point out the many pitfalls in matters statistical, which are ever ready to catch the unwary.

The course of lectures had been framed on such practical lines as would best enable the student to prosecute his farther investigations unaided.

If it is asked, What is the value of statistical work? it must be answered that it is, or should be made, a part of the educational force of a country.

A knowledge of statistics, and of how to handle them in a scientific sense, is an essential aid to proficiency in medicine, law, journalism and, above all, in politics.

STONES IN THE HEAD.

PAINTERS have in all times taken delight in reproducing scenes of medical life, but at no epoch was such tendency shown to a greater extent than in the middle ages. Seizing subjects of the oddest appearance from life, they reproduced with the hand of a master a realistic picture of neuropathic disorders and of the most varied pathologic lesions. In celebrated canvases we may see, in attitudes of the most scrupulous accuracy, images of prominent neuroses, such as hysteria, and of malformations, such as club foot and rickets. Messrs. Charcot and Richer's splendid work, "Les Demoniaques et les Malades dans l'Art," has brought to light the large number of artistic productions in which scenes of this kind are found. Yet they have confined themselves to a special point of pathology.

Dr. Henry Meige, one of our young confreres, whose artistic erudition is in no wise inferior to his medical knowledge, has, in his turn, chosen to glean in this rich field of observations, and, in a series of very remarkable studies published in the "Iconographie de la Salpetrière," gives us a criticism, as sagacious as it is interesting, of the principal painters of res medica. He has been kind enough to put at the disposal of this journal proofs of some of the engravings that illustrate his last memoir relating to operations upon the head, and for this we heartily thank him. Our readers will, from these specimens, be able to judge of the artistic interest of such researches.

It is especially in the Flemish and Dutch schools that we find these scenes of medical life reproduced—scenes that are now real and now purely satirical. Some pictures give us the real image of a woman who is dying of cardiac dropsy, as in Gerard Douw's celebrated canvas in the museum of the Louvre, of a young anæmic, as in Van Hoogstraatin's "Malade," and of a hysterical person, as in Rubens' "Possedée." In most cases, on the contrary, they are scenes in which charlatans figure—true caricatures. Subjects abound, and at that epoch, as is the case in our own day, charlatans and tooth pullers were not idle. As at our fairs and as with the Mangins of the nineteenth century, the operators and "fake" doctors and the medicastors

FIG. 2.—"STONES IN THE HEAD." FROM A PAINTING BY JEAN STEEN, IN THE BOIJMANS MUSEUM AT ROTTERDAM.

of all sorts made a display of their erudition in public, and their harangues were wanting neither in wit nor spirit. These are the scenes that the Flemish painters especially strove to reproduce, in scourging the subjects with their satirical pencil.

The figures that we place before the eyes of our readers reproduce scenes in which operations for "stone in the head" are concerned. It may be asked what operation the master painters desired to make fun of. There exist upon the scalp none of those calculous productions such as we meet with in the ducts of some glands or in certain reservoirs of the organism, such as the gall bladder and urinary bladder. As for a tumor lending itself to an operation performed by a medicastor or by merry andrews, as shown in these pictures, we know scarcely anything but the sebaceous cyst—the common wen, the caseous contents of which may sometimes become cretaceous and of a hardness approaching that of stone. There also exist adipose tumors disseminated in the forehead and upon the skull, all productions that can be quite easily extirpated by a few incisions of the scalpel. Important operations upon the head were assuredly known in those times, since trepanning, which was known to Hippocrates, dates back, as has been demonstrated by Broca, to prehistoric times. But our compeers would not have thought of so audacious tentatives, and if they had had only wens to extract, there was no need of triumphantly causing a stone or heaps of stones to burst forth.

In a very judicious interpretation of these engravings, Dr. Meige reaches the conclusion that it is a question here in most cases of purely factitious operations applied to persons of unsound mind. In the fifteenth and sixteenth century, instead of "wheels in the head" being spoken of, it was vulgarly said of individuals not well balanced, or a little daft, that they had a "stone in the head," and if, by chance, one of these unfortunates regained his reason, it was said

FIG. 1.—"STONES IN THE HEAD." FROM A PICTURE BY BRUEGHEL LE VIEUX, IN THE CABINET OF PRINTS OF THE AMSTERDAM MUSEUM.

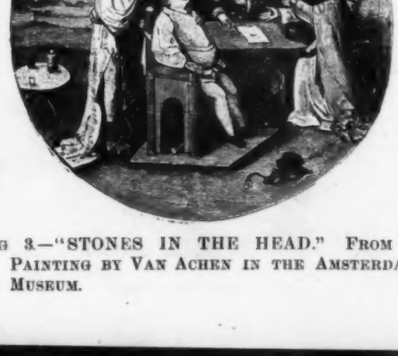


FIG 3.—"STONES IN THE HEAD." FROM A PAINTING BY VAN ACHEN IN THE AMSTERDAM MUSEUM.

none the less commonly that a stone had been extracted from his head. This mode of expression dates back, it seems, to the romances of King Arthur, and, as our confrere observes, it fully explains the mystery of these pictures of operations upon the head.

If this phraseology was current with the public, what is there surprising that the charlatans of the epoch should have adopted it in order to make the innocent and simple believe that they were in possession of the surest process of curing their terrible infirmity for ever. Do we not in our own day see deranged persons who are persuaded that a serpent is consuming their entrails, or that some one is piercing their skull with a gimlet, and do we not see simple maniacs possessed of similar ideas? Do not neurasthenics have a cap that weighs heavily upon their head and constricts their brain? Have not the hysterical their famous "clavus," and are not all such people, less educated than those of our own day, or even educated to the highest degree supposable, ready in the paroxysm of their sufferings to undergo any operation that one would desire them to in order to be forever delivered from pain? It was so of old, and even more so at the epoch at which sorcery had as yet lost none of its claims. It therefore appears to us logical to regard these operations as pure phantasmagorias of charlatans. The pictures, moreover, are here to prove it.

Look at that of Brueghel le Vieux, of the Amsterdam Museum (Fig. 1). We are in a genuine laboratory; operations are being performed without truce or mercy. Three surgeons are not too many to respond to the influx of patients. A rustic, who has already been operated upon, is taking a sly glance at his neighbor, who is yelling with pain and pushing away the assistants while the operator is preparing to remove the famous stone, and to this effect has seized a formidable pair of nippers. To the right, another operator, wearing a fantastic long straight hat, is making an incision. In the background, an assistant is attending to a potbellied fellow, while a fourth is endeavoring to persuade an unfortunate who asks only to reach the door. These scenes of suffering make no impression upon the big monks.

Another of Brueghel le Vieux's pictures is still more suggestive. It is a true caricature, a charge at full tilt upon charlatans. The scene is no longer located in a shop, but in the open air, and it is upon a stage resting upon barrels that the operator (who is alone this time) is exercising his wonderful talent. The crowd comes running up; and what a series of types! Some of the individuals are dumfounded, some are frightened, and others are as jubilant as if at the approach of a savior. One unfortunate has just passed through the operator's hands, and an assistant is pouring a healing liniment upon the gaping wound, while the victim, with a melancholy eye, is contemplating the famous pebble extracted from his head. Here is another about being put upon the fatal chair. The surgeon carefully examines the body of the victim with his lantern. The patient yells, but a matron holds his head firmly. Look at this fellow that they are bringing. Upon his forehead there is a tumor larger than an orange. Concealed beneath a stool, a confederate is present with a basket full of stones ready to be passed at the right moment, like the ball to the juggler; and he is a confederate upon whom reliance can be placed, and who will be mute, since his lips are closed with a padlock.

The satirical intention of this curious picture is, moreover, noted by the artist himself in a little sketch at the side in which he has placed his signature. It is a large egg, containing an operator and his victim. Stones pour out of the head in a shower and fall outside of the shell.

In a picture by Jan Steen (Fig. 2), we find again the same satirical intention, although the scene is treated in a less fantastic manner. The operator must be a man who is known. It is no longer upon a public square that the operating is done, but at home, in a comfortable Dutch interior. But we have here again the adroit confederates—the matron with cunning air and the boy who laughs at the rich farce and who gradually hands out the pebbles, which the mother charlatan pours over the neck of the patient, exasperated with pain.

The scene figured in the picture of Jerome van Achen (Fig. 3) would be considered less grotesque were it not for the fantastic carriage and accouterments of the operator. His gown, headgear and everything down to the odd stool through which he adds to his height is extraordinary. The serene face of the patient is none the less so. Most certainly, if the few stones that another doctor is showing to the onlookers have just been extracted from the patient's head, local anæsthesia must have been employed upon him. He smiles with a sanctimonious air as if he had just been freed from the most atrocious pain through enchantment.

Scenes showing operation for stone in the head are very numerous. Dr. Meige has been able to collect drawings of more than a dozen, which he reproduces in his work, and perhaps there are some that have escaped him. It is a series that he is to continue, and that we hope he will permit us to use for this journal.—La Nature.

WINTER FISHING IN THE URAL.

WINTER FISHING IN THE URAL.

AT the northern extremity of the Caspian Sea, along the Ural River, which separates European Russia from Asia, there live some Cossacks who, like those of the Don, form a military population, but are, besides, confirmed fishermen. All this part of the territory, which is placed under communal government, belongs to them without reserve, and here, under their military chief or "ataman," they live in a state of complete individual liberty, being compelled, however, in return for the great privileges accorded to them by the Czars, to furnish annually at their own expense a body of cavalry of from 3,000 to 4,000 men for the service of the Russian army. It is in order to supply their own wants, as well as those of their fellows who are following the flag, that they extract riches from the Ural during the year.

These fisheries are so wonderful that they leave those who have not indulged in them incredulous. All the periods and the exploitation of them are directed by severe and intelligent regulations, and wo be to him who violates the latter. Before the time stipulated, no one must approach the banks of the river, no boat must plow its surface, and no noise and no gun shot must frighten the fish, which then accumulate to such a degree that a stone thrown at them does not disturb them.

The fishing does not cease in winter, but at this period becomes one of the most indulged in and curious of sports.

No person of the commune would miss the "bagrenie." When the ice is thought to be sufficiently strong to bear the true army formed by the fishermen who are to come from every part of the territory, an order is communicated by the administration that all shall repair to the town of Uralsk for the beginning of the fishing. It is then that the Cossacks arrive by thousands, young and old, all the same, in their picturesque costume of big fur hats, gloves and waterproof shoes. In one hand they hold a pike and in the other two rods terminating in hooks. The longer one of the latter serves for seeking the fish in the depths of the river, and the shorter one for holding it when it is within reach of the hand.

Thousands of horses and sledges encumber the banks, which are lined by a feverish and agitated crowd anxiously awaiting the signal that is to be given by the ataman. The latter stands in the middle of the river. The cannon booms, the mass of humanity rushes upon the ice, and soon there is nothing heard except the precipitate strokes of the iron pikes that are cutting into the frozen surface. The latter becomes a sieve formed of a multitude of small holes into which the fisherman incessantly thrusts his hook, and whence he rarely withdraws it without a fish. The river, as far as the eye can reach, seems to bristle with pikes and spears, while the snow becomes red with the blood of the fish that cover it. Night scarcely puts an end to this true fishing orgie, which lasts about a month, say from December 15 to January 15, and which is afterward continued with nets.—L'Illustration.

HISTORY AND METHODS OF TESTING BUILDING MATERIALS.*

THERE is no record in classic literature which gives us any reason to believe that the ancients made any tests of the materials which they put into their buildings. The forms of ancient architecture, and particularly of the architecture which antedated the Roman empire, were such as did not call for any nice consideration of the strength of materials. The simple and massive forms of an Egyptian or Grecian temple were such that they performed their functions with an abundant margin of strength. In their general engineering works the ancients relied upon observation and the accumulated experience of the past, and chose their brick, stone and mortar accordingly. With the introduction of the arch and the dome of Roman architecture, there was a call for more careful proportioning of parts; and there is evidence that the resulting thrusts were considered and provided for. Yet it remained true of the Roman, as of the earlier

* Lecture delivered by Ira H. Woolson, E. M., Instructor, School of Mines, Columbia College, before the Polytechnic Section, American Institute, New York.

architects, that the massive forms in which they built were able to carry the superimposed loads with a large factor of safety. With the development of the Gothic architecture, with its heavy thrusts and severe concentration of loads, the materials employed began to be strained up to and beyond their limit of endurance, and bulging walls, twisted columns and falling towers show very clearly that in these mediæval times, the art of building was purely tentative as regards the strength of the materials employed to perform the structural duties assigned them.

It is evident that their calculations were largely of the nature of guesswork, and that of the science of testing materials, and we now understand and practice it, they knew nothing at all. The present exact and scientific method of testing building materials has been rendered necessary by the gigantic scale and cost of modern buildings, and by the size, costliness and complicated forms of manufactured iron and steel. If the architect of a modern office building of fifteen to twenty stories were to build as the ancients built, its cost would be prohibitive and its bulk would render it unserviceable. A modern railroad bridge, if built on the massive lines of Ethiopian or Egyptian construction, would collapse under its own weight.

The costliness of modern building material, the high price of labor, the desirability of speed in erection, and the general keen competition of the hour, make it imperative upon the engineer and the architect to use the least possible amount of material that will safely carry its load or perform its mechanical duties.

A frequent method of determining the safety of a structure is to apply a trial load considerably in excess of the maximum load which it is designed to carry. While such a test may sometimes reveal defects, it is also liable to develop them by overstraining the material. Moreover, though such a trial may show that certain contract requirements are fulfilled, it does not supply the most important factor in the problem, viz., the percentage of safety.

A more exact method is to test the actual strength of the separate members of the structure. This is the modern practice. Duplicates of the separate parts, whether in the simple commercial shapes in which they come from the mill, or in the form of full-sized built-up members, are tested to destruction. This gives the engineer the actual breaking strength of his material, and upon this he can base his unit of stress and verify his formulæ.

There are two methods of making mechanical tests: one in which the object is simply to determine the ultimate strength of the sample submitted; the other, and more elaborate method, which involves a careful consideration of all data which in any way relate to the strength of the test piece—the information so obtained having permanent scientific value. Besides the ultimate breaking load, such a test requires the determination of the elastic limit, the percentage of elongation or deflection, the reduction of area, the modulus of elasticity, and any other data that concern the strength of the specimen and result from the stress applied. The value and necessity of detailed tests of the above character is to-day universally recognized, and the test requirements in specifications for iron and steel structural work belong strictly to the scientific standard.

The exact knowledge of the ultimate strength of his material enables the engineer to vary his unit of stress in the various parts of a structure according to the nature of the work they have to do, which is a great advance upon the old method of adopting an all round "factor of safety," and applying it indiscriminately to the various members.

The work of a modern testing laboratory covers every possible kind of structural material; and it does not merely ascertain the present breaking strength, but it takes note also of the composition and durability of the specimens which are submitted. Strength is the most essential element, but durability is scarcely less so, especially in the case of the various building stones, which are taken from the shelter of their native bed in the quarry and exposed to the destructive action of wind and weather.

Dearly bought experience has shown that a stone which, when first built into a structure, possesses ample strength and great beauty, may with the lapse of time, and often at a very early date, begin to show an ugly discoloration or lose its original consistency. Building stone should be submitted to careful analytical test; and its powers of resistance to heat, frost, and atmospheric attack should be carefully ascertained. The lecturer quoted the case of a certain church, recently erected in New York City, into whose walls a large amount of terra cotta had been built which soon began to show a serious discoloration. After the loss of much time, and at the cost of much expense and annoyance, it was ascertained that the terra cotta contained a compound of manganese, which became soluble under the action of the atmosphere, and caused the disfigurement. It cost over $20,000 to take out the defective work and replace it with reliable material.

A more notable instance of the necessity for analytical tests of building stone is that of the Custom House in Chicago. The discoloration is caused by the existence of a small amount of mineral oil here and there within the stone. The lecturer showed some lantern slides illustrating the attempted restoration of the stone, which showed a large number of small patches, where the stones had been cut out and new stone inserted. The Houses of Parliament, London, are causing grave anxiety on account of the tendency of the stone to disintegrate under the action of the weather.

Every large lot of building stone should be subjected to test, or at least it should not be accepted on the strength of the fact that other stone of the same variety had shown good results. Stone of the same variety taken from different quarries may differ greatly in quality—one being excellent, another worthless. To use stone of the same variety from one quarry, because that from another quarry had stood the test was perilous. Yet this is often done. The varying quality of the brownstone used in New York City is clear evidence that the same variety may produce both excellent and worthless bodies of stone. An engineer would not think of accepting steel trusses whose strength had been calculated from tests made upon similar trusses built in some other shop, and whose shapes had been rolled in some other mill.

One of the earliest investigations of the strength of building materials on record was made by that remarkable physicist Galileo, who was attempting to determine the laws governing the strength of wooden beams. He gave to the world about the year 1638 seventeen propositions on elasticity, fracture, and strength of rods, beams and hollow cylinders. The value of Galileo's deductions was greatly impaired, and his conclusions rendered erroneous, because he failed to recognize the elasticity and flexibility of the individual fibers composing his beams.

The first practical testing work the lecturer had been able to discover was done between 1700 and 1774 by M. Parent, Petrio Musschenbrock and M. Buffon. The latter two are credited with being the first to investigate the strength of iron, which was now forcing its way into building and engineering construction.

The distrust with which it was at first received stimulated its advocates to prove its value by tests of many kinds; and, incidentally, by way of comparison, tests began to be made upon the commoner structural materials. Rennie and Barlow followed, and they did much pioneer work between 1800 and 1835. Barlow's apparatus was very crude and forbade close results. The test piece was suspended between end supports, and weights were loaded on to a tray, which was suspended from the center of the specimen. Tredgold, Fairbairn, Hodgkinson, Kirkaldy and many others followed. Fairbairn made use of the principle of the multiplying lever in his machine and so at once reduced its bulk and increased its power.

The most important tests in this country have been those undertaken by the government. Among these the tests of building stone by the Capitol Commission and of metals for cannon by Major Wade, in 1856—the latter very exhaustive—were among the earliest. The government report of 1875 on tests of building stones was extensive in its range, and has for many years been the accepted authority. Recent tests on modern testing machines, however, have shown that these tests are not thoroughly reliable. Later the government purchased and set up at Watertown Arsenal the famous Emery testing machine. This machine, in spite of its great capacity, is marvelously sensitive. Engineers in both the old and new world admit that it is the most perfect instrument of its kind in existence. The government tests on this machine cover the widest possible field; and it is much to be regretted that the large amount of valuable data which has been thus collected is lying idle in the government archives for lack of the small appropriation necessary for its publication.

In addition to the government work a few investigators, such as Profs. Lanza, of Boston; Bovey, of Montreal; Thurston, of Ithaca, and others, have done valuable work.

A number of views were shown which illustrated the different types of machines, from the crude devices of early experimenters to the highly developed machines of to-day. The subject was further illustrated by a selection of specimens of steel, wood and stone, etc., which had been tested to destruction in the laboratory of Columbia College.

SELECTED FORMULÆ.

Salicylated Vaselin (Dieterich).—

Paraffin (kerosene) oil—sp. gr. 0·840	60 g.
Paraffin (solid)	40 "
Salicylic acid	2 "
Oil bergamot	2 gtt.
Oil citronella	2 "
Oil wintergreen	1 "

Mould the finished mixture in sticks and put up in appropriate tin boxes.

Filling in Granite Work.—A filling that is used to fill up holes and to patch up nicked corners, etc., in granite monuments is made by melting gum dammar in a shallow vessel, over a water bath, so as not to burn it. When quite thin, stir in granite dust, and add enough marble dust to lighten it to the color of the granite. Stir in all the dust the gum will easily hold; roll out in long sticks and it is ready for use. To apply, heat an iron red hot and hold it over the stone, and at the same time hold the stick near the monument and it will melt, and can then be pressed into the cavity. When cold, pare down with a sharp tool and touch it up lightly with a bush hammer or chisel.

Renovator for Clothing, etc.—

Castile soap (white)	2 ounces.
Aqua ammonia	8 "
Sulph. ether	2 "
Spts. vini	2 "
Glycerine	2 "
Oil gaultheria	2 drachms.
Aqua (soft) q. s.	1 gallon.

Dissolve the soap (by heat) in the water; also the oil gaultheria in the alcohol; then add the other ingredients in their proper order.—Pharmaceutical Era.

Antiseptic Liquid.—The following formula is in use in some of the hospitals and dispensaries as an antiseptic dressing:

Boric acid	240 grains.
Salicylic acid	30 "
Water	2 pints.

Dissolve.

Butter Color, No. 1.—

Ethereal extract annatto	1 ounce.
Oil (olive or cotton seed)	100 ounces.

No. 2.—

Purified annatto, powd	10 ounces.
Oil	100 ounces.

Digest for two hours in a steam or water bath, allow to stand for one week, then decant.

Of either of the above liquids 6 drops added to 1 quart of cream is sufficient.

Essence of Anchovies.—Pound 1 lb. of anchovies in a mortar; put them into a pipkin with 4 oz. of the best vinegar and boil for a few minutes; then pulp through a hair sieve. To the portion that passes through the sieve add 2 oz. of salt, the same quantity of flour, and sufficient water to give it the proper consistence. Boil them together for a few minutes and color the mixture with annatto. A little Cayenne pepper is sometimes added.

Benzine Paste for Removing Spots.—

Hard soap, white	12·0 g.
Water, boiling	20·0 "

Dissolve, and when somewhat cooled down, add

Stronger ammonia	3·0 g.

Stir, and add, little by little,

Benzine, deodorized	100·0 g.

Perfume, to suit.

Soaps with an excess of alkali ("ivory," for instance) give best results.—Western Druggist.

Welding Lead.—An ingenious method of welding lead has been recently devised by M. Blondel. The surfaces to be joined are carefully cleaned and between them is placed a thin layer of lead amalgam. On passing an ordinary soldering iron along the line of junction, the mercury of the amalgam is vaporized, and the lead, set free in an exceedingly finely divided state, fuses and unites the two surfaces together.

To Renovate Velvet.—Mix two tablespoonfuls of liquid ammonia and two of warm water, and put it on the velvet with a stiff brush, rubbing it well into the pile, so as to take out all stains and creases. Then cover a hot flatiron with a damp towel or cloth, and hold the wrong side of the velvet over it until the steam raises the pile and it is perfectly dry.

Microscopic Fixing Solution.—Zenker recommends the following fixing material for vegetable tissue; it penetrates the tissue readily without producing any shrinking:

Distilled water	100 parts.
Mercuric chloride	5 "
Bichromate of potassium	2·5 "
Sodium sulphate	1 part.
Glacial acetic acid	5 parts.

—Intern. Journ. Micro. Sci., after Munich Med. Woch.

Ink for Writing on Glass.—Dissolve 36 grammes of fluoride of sodium and 7 grammes of potassium sulphate in 500 grammes of water. Dissolve 14 grammes of chloride of zinc in 500 grammes of water, and add 65 grammes of hydrochloric acid. Mix equal quantities of these solutions, and apply with a pen or brush. In half an hour the surface covered will be etched. —Annales de Pharm.

Ink on Silk.—To remove ink stains on silk, soak the spot in spirits of turpentine and let it stand for some time; then rub it gently between the fingers and the stain will come out and the color and texture of the silk be uninjured. This can be done by stretching the silk and putting a drop of the turpentine on it, renewing it until the desired effect is produced. The stain and odor of the turpentine will disappear in a short time.

Polishing Inlaid Wood.—To polish the metal inlays frequently met with in furniture, the following recipe will be found useful. Sift some powdered rottenstone through muslin or a hair sieve, and knead the sifted portion with sufficient soft soap to form a stiff paste; then to every ½ lb. of this mass add 1¾ fluid ounce of oil of turpentine. Put in boxes or form into balls, which soon become hard. The article to be polished must be entirely freed from grease and dirt by previous washing with soap and water with a little soda added; moisten some of the paste with water, apply it to the metal, and rub with a dry rag, when a beautiful luster will be the result. This is well adapted for household purposes.

Delicate Test for Alum in Drinking Water.—E. H. Richards contributes to Technology Quarterly the following, which, it is said, will detect 1 part of alum in 1,000,000 parts of water (1 grain in about 17 gallons): To 25 cubic centimeters of water (concentrated from 1 liter or more, if necessary) are added a few drops of freshly prepared logwood decoction; any alkali is neutralized and the color brightened by the addition of two or three drops of acetic acid. By comparison with standard solutions the amount of alum present may be determined. The logwood chips must be treated with boiling water two or three times before finally extracting for the color, as the first extraction gives a yellow color, the third or fourth a deep red.

Barber's Styptic Powder.—The majority of the preparations upon the market contain tannic acid, alum, subsulphate of iron or some other astringent substance, which, when applied, will arrest local bleeding. Here are two formulas:

1. Alum,
   Nutgalls,
   Gum arabic,
   Gum benzoin, of each, equal parts.
   Powder each separately and mix.
2. Alum,
   Gum tragacanth,
   Tannic acid, of each, equal parts.
   Powder and mix.

Used to stop local bleeding, a little being sprinkled or pressed on the part.—Mialhe, Phar. Era.

A Preventive of Insects' Bites.—The Gazette hebdomadaire de medecine et de chirurgie gives this formula:

Acetic ether	5 parts.
Eucalyptol, Cologne water, each	10 "
Tincture of pyrethrum	50 "

This is to be diluted with four or five times its bulk of water and applied as a lotion.

Fire Proof Ink.—White paper has been prepared by using borax, asbestos, etc., which will not burn. There has so far been no ink prepared which when subjected to fire is not either destroyed or rendered illegible. Luders, of Gorlitz, however, publishes, says the American Druggist, a formula as follows, which he claims will furnish an ink the legibility of which will not be affected by fire: Mix 40 parts of finely powdered graphite, 72 parts of gum copal, 3·5 parts of ferrous sulphate, 3·5 parts of tincture of galls and 14 parts of indigo sulphate, add to a sufficient quantity of water, boil and then cool, when the ink is ready for use.

ENGINEERING NOTES.

The Jaroljmek system of blasting is stated to consist essentially of the use of a piece of lime, which, in contact with water, takes the place of a time or electric fuse, the period required for the water to combine with the lime and produce sufficient heat to fire the detonator being adjustable to what appears to be an extraordinary degree of accuracy.

The Bureau of Construction and Repair has issued a statement giving the degree of completion of the men-of-war building. The monitor Terror is 98 per cent. completed; the Massachusetts, 97 per cent; the Oregon, 95¼ per cent.; the Iowa, which is to be launched next month, 54 per cent.; the Puritan, 91 per cent; the Brooklyn, 70 per cent; torpedo boats Nos. 3, 4 and 5, 22 per cent.; torpedo boat No. 8, 3 per cent.; the Nashville, the Wilmington and the Helena, 74 per cent., and the submarine torpedo boat, 5 per cent.

The roller bearing has again been tested under heavy load. A standard car truck fitted with two General Electric motors of the latest type was used in the test. One motor had the ordinary bearings in general use and the second motor was equipped with roller bearings of the Mossberg pattern. The axle with which the armature of this motor engaged a'so was fitted with the Mossberg bearings. The load was applied by a brake, the truck being suspended. In the first test, with no load, it took 190 pounds pull to start the motor with ordinary bearings, and only 3 pounds to start the roller bearing motor. With a load of 3,660 pounds it took 240 pounds pull to start the first motor and 18½ pounds for the second.

Following upon the recent government tests of timber, the Northern Pacific Railroad officials have carried out some private tests to determine the value of Washington fir as a material for car building. The tests were made in comparison with Eastern white oak, which is the material largely used at present. The best specimens were 2 in. square, and measured 18 in. between supports. 1st. Ten pieces of green oak and fir were tested to destruction. The green fir broke at an average load of 2,845 lb. and the green oak at 2,735 lb., showing 110 lb. in favor of fir. 2d. Ten pieces of well seasoned oak and fir showed the following results: Fir broke at average load of 3,900 lb., with ⅜ in. deflection; oak broke at 3,215 lb., with 1⅜ in. deflection. The tests were made at the Tacoma Railroad shops.

The "railroad race," so called, is not an incident that is specially peculiar to modern railroading. In the early days of English railroad construction such speed contests were frequent, especially between the broad and narrow gages. During a part of the year 1846 Sir Daniel Gooch's engine, Great Western, cylinders 18 in. by 24 in., was hauling a regular scheduled passenger train on the broad gage Great Western line at an average speed of 67·9 miles per hour! This was done between London and Didcot, a distance of 53¼ miles, which was made in 47 minutes; the maximum speed recorded being close upon 80 miles per hour. The distance was short and the load probably light; but the mere fact that fifty years ago a regular schedule train was running at a higher booked speed than was made on either side of the Atlantic last year will come as a possible surprise to some of our master mechanics of to-day.

The method recently adopted in demolishing a tall factory chimney at Manchester, England, is full of interest. The stack was 270 ft. high, about 30 ft. in diameter at the base, and consisted of an inner shell 1½ ft. thick, and an outer shell 4 ft. thick at the base. It contained 1,000,000 bricks, and was estimated to weigh 4,000 tons. A section of the stack, 5½ ft. high, was cut away on the side on which it was to fall, and the cut extended a little more than half way through. As the brick was cut away, spruce posts were inserted, until more than half the total weight was standing upon 130 posts which were 5 in. by 7 inch and 5 ft. long. The posts were then saturated with oil, and a mass of wood, coal, pitch, etc., was piled around them, and the whole set on fire. The stack, in falling, at first leaned gently to the south, then the lower half telescoped into itself and the whole mass crumbled down into a heap of debris, which measured 75 ft. wide by 125 ft. in length.

A comparison of a recent run of the American Line steamship St. Louis with that of the Lucania on the same date affords ample proof of the excellent weatherly qualities of the new ship. She beat the Cunard boat by an average of $\frac{1}{10}$ of a knot per hour for the whole trip. The best single day's run of the St. Louis was 527 knots, which, allowing 24 hours and 50 minutes as the length of the nautical day coming west, is at the rate of 21·21 knots an hour; the best single day's run of the Lucania was 516 knots. The Paris has made a westward day run of 530 knots and the Lucania a day's run of 560 knots. The average hourly speed of the St. Louis on this last trip was 20·04 knots, and that of the Lucania 19·92 knots. The Lucania has crossed at the rate of 22 knots an hour for the whole trip; and on one occasion, in hastening to catch the tide at Liverpool, she made 24 knots per hour for 10 hours. This, however, was in fine weather. When the seas are heavy, the American boats can a little more than hold their own.

In a recent number of Dingler's Polytechnischer Journal a novel method of determining carbon in steel, due to Mr. Peipers, is described. The method is similar in principle to the assay by touch in use for gold. A series of six bars of known carbon content are prepared, each successive one of which contains about 0·2 per cent. of carbon more than its predecessor. These bars form the touch needles, while the touchstone is represented by a slab of unglazed porcelain. To make the test, the specimen to be examined is rubbed on the porcelain, as well as the needles, producing long black patches, which are made of equal depth of tone. The slab is then immersed in a 12½ per cent. solution of copper ammonium chloride, which dissolves away the iron, leaving the carbon behind as a gray stain. The depth of this stain is proportional to the carbon in the steel. It is claimed that differences of as little as 0·025 to 0·05 per cent. of carbon can be determined in this way, when the conditions are favorable.—Engineering.

ELECTRICAL NOTES.

It has been estimated that electric railways have displaced in the United States no less than 275,000 horses, and the movement has not yet been stopped.

An interesting method of lighting by reflection is in use in the Union Bank of Australia, Cornhill, London. Incandescent lamps are fixed below the ceiling and a reflector below them renders them invisible. The light is thrown up to the ceiling, from whence it is reflected in a diffused manner all over the rooms. Sharp shadows are thus avoided.

Taking gas and incandescent lamps at equal candle power, says Electrical Age, the equivalent rates would be as follows:

Gas at $1 per thousand equals 16 candle power lamps at ½c. per hour; gas at $1.50 per thousand equals 16 candle power lamps at ¾c. per hour; gas at $2 per thousand equals 16 candle power lamps at 1c. per hour.

The Lewiston Connecting Bridge Company has been formed to construct a bridge from the east bank of the Niagara River, at Lewiston, to some point on the Canadian bank. By the bill the company is authorized to lay tracks and operate a railroad by electrical or any power other than locomotive steam power, and to lay pipes to convey gas and water and cables to transmit electricity or other motive power.

The Westinghouse Electric and Manufacturing Company has recently received an order to equip an electric railway in the Isle of Man. Another order for electric railway apparatus for the city of Coventry, England, and a third order for electric motors and railway generators for Cape Town, South Africa. The company is also about to ship an order for electric railway apparatus to Bangkok, Siam, India.

The Card Electric Company, of Mansfield, O., manufacture bending rolls operated by a 30 horse power motor run at 325 revolutions per minute under full load. The motor shaft engages two trains of gearing, one for revolving the two lower rolls, and the other for raising and lowering the upper one. The motor being reversible, the manipulation of the rolls for bending plates on any circle is easily and quickly accomplished.

All of the motormen on the North Hudson County Electric Railway have served their time in the repair shop, says the Electric Railway Gazette, and when a vacancy in the corps of motormen occurs it is filled by one of the repair shop hands, who is properly trained for the position. Thus the motorman has a practical knowledge of the machinery which he handles, the accidents that are liable to occur, and their causes, which latter he, of course, takes pains to avoid. As a result an enviable service is obtained, and the repairs are largely reduced.

The Pacific Cable Company, of which Mr. James H. Scrymser is head, asks a bonus of $160,000 a year for a period of twenty years from the United States government, in return for which the company pledges itself to transmit all government dispatches free of cost. Japanese rates are to be $1.25 per word; Hawaiian rates, 35c. per word, and the press dispatches will be sent for one-fourth the above rates. It appears that Col. Spaulding, representing an English company, has already secured a grant from the Hawaiian government which claims to be exclusive.

High Tension Illumination.—The Chronik of the Vienna Elektrotechnischen Verein contains notes of the work of Mr. P. Spies, of Berlin, on high tension illumination. Tesla's work is referred to, and Mr. Spies thinks that what has been done in this direction will not end with the production of mere playthings, but that in all probability in the development of the Geissler tube will be found the "light of the future," a light without heat. In this way the parasite heat rays, which in our present electric installations reduce the energy effective in giving light to from 2 to 4 per cent. of the whole, will be reduced to a minimum, and for the first time in the arts a cold body will come into use as a source of light.—Electrical Engineer.

Prof. John W. Langley has been conducting at the Case School of Applied Science, Cleveland, elaborate experiments on the application of electricity to the purification of sewage. Referring to the practical results that have already been accomplished, Prof. Langley says: The plan was first tried in the village of Brewsters, N. Y., which is situated on the watershed of the Croton supply to the city of New York. The drainage from this town found its way into an adjacent marsh and from there into streams running into the Croton basin. An electrical engineer of the name of Wolf proposed to decompose sea water by electrolysis, and to turn the solution of chlorine thus obtained into the drainage from the village. The plan proved to be completely successful, as shown by a report issued by Dr. Cyrus Edson, health officer of New York, in 1892 and 1893. By an expenditure of a little over five horse power to work a dynamo, the sewage was completely disinfected, at an estimated cost of less than 1 per cent. of that of the older methods using chloride of lime or carbolic acid.—Electricity.

"Now that the New York elevated roads have again taken up the subject" of electrical traction, says the Electrical Engineer, "it is interesting to compare the present proposed system with those which have preceded it. The first to undertake electrical work on the elevated roads, it will be remembered, was Mr. Leo Daft, who, in 1884, placed his locomotive, the Ampere, on the Ninth Avenue line. He was succeeded by Mr. Frank L. Sprague, with a car equipped with individual motors, practically the same system now in operation in Chicago and in Liverpool; and, again, Mr. S. D. Field attacked the problem with a locomotive of his direct connected crank type. The present experiment is noteworthy, in that while following the general lines of a motor car of the type which the World's Fair Intramural road made so familiar, it introduces the additional feature of a storage battery carried on the motor car." The use of a storage battery on the car in connection with electric propulsion from a trolley line is an innovation which will afford some very useful comparative data.

MISCELLANEOUS NOTES.

The total value of the output of diamonds from the De Beers Consolidated Mines, South Africa, last year was $15,530,000. The net profits were $11,245,000.

The 15 ton bell, which has recently been placed in position in the belfry of St. Francis church, Cincinnati, is the largest swinging bell in the world. It is 7 ft. high, 9 ft. in diameter at the bowl and 5 ft. in diameter at the crown. It can be heard at a distance of 10 miles.

Corrosion of Aluminum.—Herr Donath (according to the Gas World) says that aluminum is not at all attacked by boiling distilled water free from air, but that it is distinctly attacked by ordinary boiling water. Gypsum in the water renders it harmless, but chlorides, and especially nitrates, make it attack the aluminum. Fat or carbolic acid have no effect by themselves; but with ordinary water, boiling seems to make these attack the aluminum. Herr Zmerzliker confirms these results, and says that hydrogen is given off.

While the quality of Bordeaux and Burgundy wines this year is unusually good, the quantity, 600,470,415 gallons, is less than three-fourths of last year's vintage and almost one-half that of 1893. It is the smallest vintage since 1889. The yield of the other European countries for 1895 is: Italy, 551,250,000 gallons; Spain, 385,875,000; Austria and Hungary, 131,962,000; Germany, 82,000,000; Roumania, 70,500 000; Turkey, 58,000,000; Portugal, 44,000,000; and Greece. Switzerland, Bulgaria, Servia and Russia between them, 125,325,000 gallons. Algeria and Tunis produced 95,000,000 gallons of wine.

The Eophone for detecting the direction of sound in a fog, as invented by Mr. Della Torre and recently tested in New York Harbor, consists of two sound receivers which are suitably mounted and communicate through tubes with the right and left ears of the operator. By an ingenious arrangement the operator hears a sound with equal intensity in both ears only when an index needle is pointing in the exact direction from which the sound proceeds. The test was made with two tugs, on one of which the eophone was placed. The signaling tug was placed at some distance, and out of sight, and though the wind was blowing at the rate of 35 miles an hour, the eophone indicated its position in the bay with accuracy.

European Beet Sugar Crop.—Estimates of the European beet sugar crop vary so much from month to month it is difficult to rely upon them; but there seems to be a consensus of opinion that this year's crop will not amount to more than 4,000,000 tons, if so much. This will mean a reduction on last year of about 840,000 tons, and as the production of cane sugar in Cuba is certain to be diminished on account of the revolution, while the West Indian crop generally is said to be smaller, the stock in Europe is likely to be materially reduced in the next few months. It is noticeable that the low price of sugar this year has caused a great increase in consumption, for, according to German official statistics, the quantity of beets consumed in 1895 amounts to 145,210,395 cwt., as against 106,443,515 cwt. in 1894.

The following is taken from the London Daily Financial News: "Some remarkable statistics were given recently by Mr. W. E. Hubbard at the annual meeting of the London and County Bank. He stated that the checks issued during the year amounted to 14,000,000, and, if put together, they would reach 2,000 miles in length and cover 70 acres of ground. In coin the bank's staff had taken in and paid out about $170,000,000 in the twelve months, out of which only $58 50 was short, while on the other hand $20.50 too much was taken, so that the total discrepancy came to $38, or an average of about $5 in every $25,000,000. The bank has 126,452 accounts open and 20,000 deposit accounts, with liabilities to customers of $192,000,000, against which the chairman said there were liquid assets of 77 per cent, to 78 per cent, and the value of the securities at to-day's prices is $4,925,000 more than the amount at which they stand in the balance sheet."

Under the title, "The Magnitude of the Poultry Industry," the American Agriculturist gives the following figures:

The egg product of last year and number of fowls in town and country compared with farm poultry only five and fifteen years ago.

[Stated in round millions.]

	1895.	1890.	1880.
Number of fowls	383	286	126
Dozens of eggs	1,141	820	457
Total value	$343	$275	$118

The same journal further says that, despite the big increase in the poultry business the last five years and the close attention now given it, there is room for still greater expansion before it is overdone.

The Oldest Prescription in the World.—In the course of a deeply interesting lecture delivered by Prof. A. Macalister, M.A., M.D., F.R.S. (professor of anatomy, Cambridge) at Firth College, Sheffield, on "Studies in Ancient Egyptian Literature," some of the earliest medical writings were referred to and explained and translated by the professor. Photographs of soiled and seared papyri, together with the photographs of the mummified monarchs and magicians who wrote them, were depicted on the screen. Among the earliest prescriptions shown by the professor was one for a "hair wash" for "promoting the growth of the hair" for the mother of King Chata, second king of the first dynasty, who reigned about 4000 B. C. It is as follows:

Pad of a dog's foot	1
Fruit of date palm	1
Ass' hoof	1

Boil together in oil in saucepan. Directions for use: Rub thoroughly in. Considering the non-hirsute nature of the ingredients used, says the Montreal Pharmaceutical Journal, one would imagine that homeopathy was in those bygone days carried even to a greater extreme than in latter times.

INACCESSIBLE MARITIME LIGHTS.

By ELMER LAURENCE CORTHELL, C.E., D.Sc.

THE writer was recently called upon professionally to report upon the question of the best and most economical method of lighting the sea end of certain harbor works often exposed for many consecutive days to so heavy a sea as to make the light inaccessible to the keeper. The investigations opened such an interesting field that the writer desires to give the results to the profession. He does not propose, however, to go into the technical details, which would probably be uninteresting to the general reader. However, for those who desire to study these details, references at the end of the article will indicate the official sources of information.

The principal methods employed satisfactorily to operate lights and beacons, inaccessible at times, are three in number; electricity, mineral oil and gas. These methods will be described in the above order.

The most unique system of electric lights to guide navigation is that in use at the entrance to New York Harbor. Since its installation, in 1888, there has been so much of descriptive matter published about it that only a resumé is now required, and were it not that such great benefits have resulted to navigation, it might be unnecessary to more than allude to the installation. In order that the importance of the system and its necessity may be appreciated, a general map of New York Harbor (Fig. 1) is given and referred to for more detailed information.

New York Harbor has two communications with the ocean, one by way of Long Island through East River and Hell Gate and the other through the Narrows, between Staten Island and Long Island. The latter is the only one now practicable for sea-going vessels of the larger class, and therefore is of vast importance to the commerce of the metropolis. There are two principal channels at the Narrows, as shown on Fig. 1; in fact, there are several channels across the entrance bar, used according to their depth. Nearly all of the coast steamers and sea-going vessels of moderate draught use the South and Swash channels, as these are by far more direct than by the extremely tortuous Gedney's and main channels, which constitute the only entrance to New York Harbor by the great ocean liners and deep draught ocean freighters. An inspection of Fig. 1 will show the impracticability of navigating these channels on a very dark night without some adequate system of lights in the channelway. The direct range light on shore is 13 miles distant. It was generally necessary for steamers to lie to outside for daylight before entering the harbor. The entrance was therefore practically closed at night to deep draught vessels. It was particularly necessary to light Gedney's Channel, the main channel being quite plainly marked by a sufficient number of range lights on the shore, and then, too, the channel is wider. It became still more important to light Gedney's Channel from the fact that the government had expended large sums of money in dredging it to secure a depth of 30 feet through it at mean low water, with a width of 1,000 feet. It became therefore proper to secure the largest possible results to navigation. The great distance of the channel from the shore made it necessary to adopt some system of floating lights. After studying several methods a direct current system of electrically lighted spar buoys was determined upon and installed in 1888, the first exhibition of the lights being on the night of November 7. The system has been operated successfully to the present time.

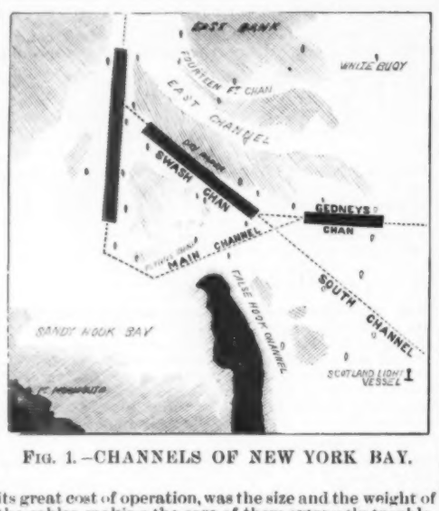


FIG. 1.—CHANNELS OF NEW YORK BAY.

one small cable only. The size of the direct current cables was 1⅝ inches, that of the new single cable $\frac{7}{16}$ of an inch. The original system provided six lights, the new system ten lights; by the former the channel was lighted 4,000 linear feet, by the new system 8,000 linear feet.

The economy of the new system in maintenance is very considerable and the new dynamo and entirely new installation did not greatly exceed the cost of one of the three conductor cables of the first method. One of the principal objections to the first method, besides its great cost of operation, was the size and the weight of the cables, making the care of them extremely troublesome in winter, when from any cause they had to be lifted to the surface of the water by underrunning.

As early as 1890 the great electrical and other advantages of the alternating current system of operating incandescent lights on long circuits led to experiments of testing it for lighted buoy systems. These experiments showed that the proposed method would be more economical and altogether more satisfactory. The experience gained at Chicago with a cable laid in the water from the Exposition to the city, about 7 miles, and further study and experiment, led to the very satisfactory method only recently installed at Sandy Hook and above mentioned. Figs. 1 and 2 will show clearly the new system. The spar buoys are juniper wood 50 feet long, held in place by mushroom anchors weighing 4,000 pounds. The lamps, which are attached to the top of the buoys, are 100 candle power of improved design, with 5 inch globes. The length of the cable used is about 6¼ statute miles, with the additional length of nearly 2 miles to the southwest spit buoy.

The details of the transformers to increase or diminish the voltage of the current, as well as the details of the dynamos and the cable connection with the lamps, can be studied in the reports alluded to below.

The value of the system to commerce may be seen by the following table, which shows the steady increase of vessels using Gedney's Channel at night, since the installation of the electrical buoy plant, November 7, 1888.

FISCAL YEAR.	NUMBER OF VESSELS.			AVERAGE PER MONTH.		
	Bound in	Bound out	Total	Bound in	Bound out	Total
1888-1889	171	53	224	24·0	8·0	32·0
1889-1890	377	192	569	31·4	16·0	47·4
1890-1891	470	297	767	39·1	24·7	63·8
1891-1892	533	252	785	44·4	21·0	65·4
1892-1893	487	215	702	48·7	21·0	70·2
1893-1894	648	347	995	54·0	28·9	82·9

Percentage of increase per month, 1893-1894 (82·9) over 1892-1893 (70·2), 18·09 per cent.

Percentage of increase per month, 1893-1894 (82·9) over 1888-1889 (32·0), 159·06 per cent.

Some very interesting facts may be gathered from reports and correspondence with officials of the French government in reference to methods by electricity, mineral oil and gas.

The electrical method, while not, in France, applied extensively to lighting inaccessible points, will be seen to be easily applicable to this purpose. An electric light at the end of a long breakwater that can be operated from the distant mainland, that can be turned on and off at will while the waves are dashing over the structure, has many manifest advantages. The economy of it also is evident, if there should by chance be in the vicinity an electrical plant already installed for lighting the town or city. In event of accident to the lamp, or the burning out of the filament, a second lamp, in fact, several lamps, could be arranged. The current could be automatically turned into them successively. The recent adoption of the alternating current method admitting of only one small armored cable makes the electrical method still more applicable and economical.

The opinion of the eminent electrical engineer Mr. Franklin L. Pope was strongly in favor of the electrical method in the special case which the writer had in hand, and he was willing to guarantee that it would in every way be successful if properly installed. The case mentioned was the lighting of the sea end of a dike 7,000 ft. from shore, where at times the light could not be reached by the keeper for several days at a time. The method, worked out in sufficient detail to prove its practicability, was to lead a cable from the light in the light tower, which was to be about 45 ft. above the water, through a tube down through the dike, and then by easy curves to the surface of the rubble slope of the work, and then along the inner slope and out of danger from any movement of the stones by the waves or from the anchors of vessels, to the shore and thence to the dynamo. The writer has seen a similarly exposed cable at the works at the mouth of the Maas, transmitting by means of a storage battery the movements of an automatic tide gage set at the extreme sea end of the jetty, 7,000 ft. from the shore, to the engineer's office, nearly two miles distant. The report there was made continuously upon the paper roll, regardless of the fact that the tides of the tempestuous North Sea covered the works twice a day with from 6 ft. to 8 ft. of water. In this case the cable was laid in an exposed position, directly on the top of the works nearly the entire distance.

The French government has several electric lights upon isolated rocks at sea. It has in all thirteen lighthouses lighted by electricity, several of them situated near great shoals.

We come now to perhaps the most fully developed method, that by common mineral oil. In Sweden and England, but particularly in France, has this method been highly perfected. Some very ingenious methods have been devised to overcome what will at once be seen to be serious obstacles, particularly the uneven burning of a wick and its early wasting away by being constantly lighted. It is well known that the chemical action upon a wick causes the light after a while to go out, but if the same charred wick be raised again, it will continue to burn. In order, therefore, to obtain permanency to the lights, it is necessary to use a wick already charred and to regulate its height in some way so as to have a uniformly steady flame for perhaps several weeks without attention. It was found necessary to deposit upon the wick a layer of tar by a peculiar method of incrusting the wick. The supply of oil is in a reservoir, the capacity of which is sufficient to keep the light burning during the entire time it

FIG. 2.—ELECTRIC LIGHT BUOYS IN NEW YORK HARBOR.

As important and even radical changes have been made, resulting from experience and the development of electrical methods, it is only necessary to state, in regard to the original installation (referring to Fig. 2, which shows the present improved system), that in this original system the direct current method was used, and in the improved system alternating currents; the original system required a three-conductor cable of large size in two nearly parallel lengths from Sandy Hook point to the channel; the new method,

may possibly be inaccessible. The decrease of pressure by the lowering of the oil in the reservoir is provided for by a very ingenious contrivance. It consists simply of interposing between the reservoir and the burner a supply regulator that serves to maintain a constant pressure of oil at the lamp. A section of this apparatus is shown on Fig. 3, in which S is the supply pipe to the lamp, A the reservoir, which may perhaps hold 100 quarts of oil, B a cylindrical float, D a cylindrical box in which B rises and falls, E is a gage and P a waste pipe. Without further description, it will be seen that the supply of oil to the box, D, is maintained at a fixed point, and the supply is renewed from the reservoir as the oil is consumed at the lamp, for the opening at F is regulated by the float and the latter by the supply in the box, B, and this is drawn upon by the supply tube, S, as the lamp burns. The supply, therefore, is made automatically, constantly and economically. The contrivance works with great sensitiveness and with entire satisfaction. The method is used at several points in France.

A permanent light of this character replaced the light at Harbor Isle, which had required the attendance of three light keepers. One has been established on the breakwater at the harbor of St. Vaast and another on the tower of Morées, near the coast of St. Nazarre, and at many other points. One particularly interesting at the lighthouse of Haut-Banc, on a lonely spot at sea, and another at Cette on the top of the breakwater. At Harbor Isle above mentioned it has been proved that the light can be kept burning with uniform intensity for 98 consecutive days and nights

In order to give a more detailed idea of the method, a vertical section and horizontal plan of the light used at Morées is given; see Fig. 4. Some details should be stated. The lantern, with a diameter of 5¼ feet, supports the oil reservoir, R; the lamp, L, rests on a central column and supports the supply tube. A little

sists of two permanent magnets separated from the armature by a slight air gap The current comes from two battery cells called 'Bloc,' filled with a solidified liquid, set up in series, and having a capacity of 550 ampere hours. Under these conditions a rotary velocity of about one revolution in ten seconds is obtained; this produces a proper rhythm, while a constant velocity is secured by means of a very sensitive regulator. The experiment shows that the apparatus may continue to revolve for five months without the intervention of a keeper. In practice, however, it would be well to change the batteries every two or three months. This would cost only about $50 annually."

The result of the experiment was so satisfactory as applied to mineral oil that the same system has been used to obtain the revolution of a group of lenses forming the apparatus of a "lightning light." There is now on exhibition at the Bordeaux Exposition a permanent lightning light, giving revolutions in groups of two and moved by electricity. At the close of the exposition this apparatus is to be installed in the lighthouse of Ville-es-Martin.

The third method for inaccessible lights is the use of compressed gas. The writer made a personal examination four years ago of the great Carnot dike at Boulogne-sur-Mer, France, and was informed by the resident engineer in regard to this method of lighting. Two years ago a descriptive paper upon these harbor works was written by Mons. Monnerque, Ingenieur des Fonts et Chaussées, published in the Annales des Ponts et Chaussées. The light is located on the extreme sea end of the curved dike about 6,950 ft. from shore. The gas which feeds the light is in a cylindrical reservoir 83¼ ft. in diameter and 15 ft. long, which holds about 150 cubic ft. The lamp, about 1 ft. in diameter, is placed over this cylinder. The whole apparatus is placed on a cylindrical masonry turret

ernment, who have very kindly given considerable of the information stated in this paper and have furnished the writer with much of the published matter employed.

The following references are given for more detailed information than is contained in this paper:

The Modern Lighthouse Service, by Arnold Burges Johnson, Chief Clerk United States Lighthouse Board, 1890.

Annual Report of the United States Lighthouse Board, 1890.

Annual Report of the United States Lighthouse Board, 1894.

Notice on Apparatus for Illumination by the French Lighthouse Service, 1893.

Navigation Works Executed in France, by F. Guillain, Directeur des Routes et Navigation: a paper prepared for the International Engineering Congress, 1893, Volume 29, Transactions American Society of Civil Engineers.

[Continued from SUPPLEMENT, No. 1055, page 16867.]

MECHANICAL ROAD CARRIAGES.

By W. WORBY BEAUMONT, M.Inst.C.E.

[Cantor Lectures before the Society of Arts.*]

LECTURE II.—Continued.

THE next great step in the development of the steam locomotive on roads was made by W. R. Thomson, who was the inventor of pneumatic tires, for which he took out a patent in 1845.† In 1867 he used large rubber tires on traction engines, and in 1870 he ran, in Edinburgh, an omnibus drawn by one of what he called his road steamers fitted with rubber tires. The omnibus was also fitted with India rubber tires and with springs 5 feet in length, and was made to carry

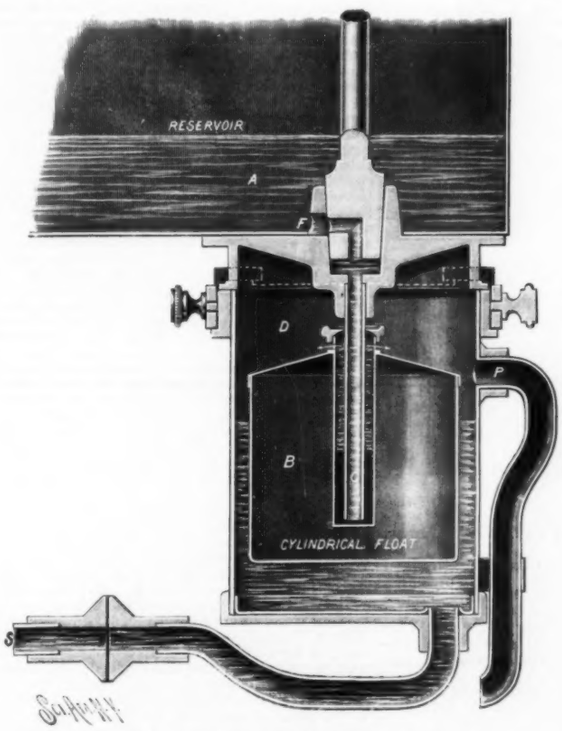


FIG. 3.—OIL RESERVOIR AND REGULATOR.

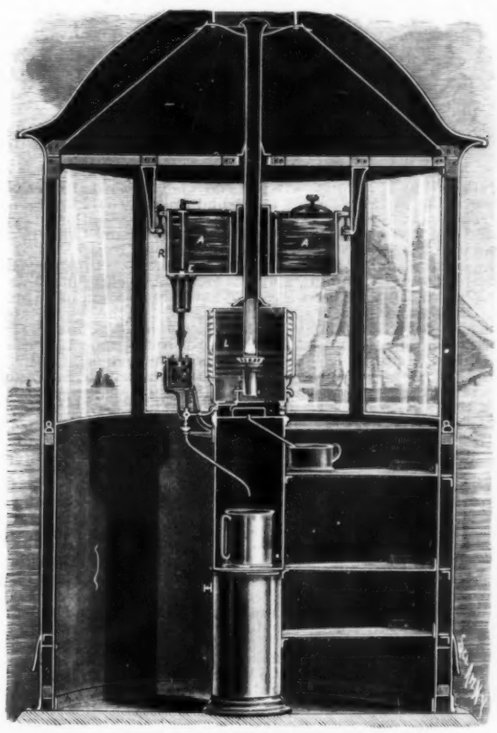


FIG. 4.—FISH OIL LANTERN.

railway is provided on which the lamp can be moved to one side for cleaning, etc. Provision is made for thorough ventilation by admitting air below, which passes up through the entire apparatus and out at the top, so regulated that it prevents the formations of mists and frosts or any other conditions that would obstruct the light or in any way affect it. The cost of the installation, with the necessary duplicate parts, is about $15,000. The apparatus spoken of above as established at Cette is similar to this

Severe winters, summer heats, mists or frosts do not interfere in any way with the light. Experience, in France and other countries, in this method shows that it is specially applicable to the lighting of inaccessible piers placed in rough water and many other dangerous places, and particularly where lights of an inferior order are suitable and where the conditions do not warrant the installation and operation of expensive lighthouses with their keepers.

Official information has been received through some recent correspondence in reference to the development of this system of mineral oil by applying an ingenious mechanism to make the lights revolve and flash.

The French lighthouse service has succeeded, by means of electricity generated from batteries, in maintaining a rotary motion of a revolving apparatus for at least two months without the care of a keeper. It applied a method which had previously been used in "lightning lights" to obtain permanent occulting lights in which the occultations are produced by a system of screens supported on a revolving mercury float, but the rotation had been performed by a clockwork movement. It was necessary to adopt some other rotating power. In the new method of rotation without clockwork the shaft itself which guides the float forms the axis of the armature of the electric motor. "This armature consists of a Gramme ring containing 64 bobbins. The current from one cell enters the armature by means of two brushes which have an arrangement for adjusting the pressure. The inductor con-

about 10 ft. in diameter. The focal plane of the light is about 50 ft. above high water. Notwithstanding this height, the spray often rises over 60 ft. above the light. On account of its exposed situation it was necessary to arrange a light that would not depend upon the daily presence of a keeper. The details of the plan above outlined are fully given in the report above alluded to.

Referring to these various examples of inaccessible lights and the methods adopted, can anything more plainly show the power of mind over matter or better illustrate the definition of engineering in the constitution of the Institution of Civil Engineers as "the art of directing the great sources of power in nature for the use and convenience of man," than a light on an isolated rock at sea, or upon a weatherbeaten end of a long breakwater on a stormy coast burning steadily and faithfully with no attending keeper for two or three consecutive weeks, and, more than that, often so arranged as to turn and flash its welcome light all this period through the dark night to warn or guide the mariner! Neither heat or cold, nor storm or shine, nor wind or calm, nor frost driving sleet snow or hail, nor the rushing waves or dashing spray overtopping the beacon, not one or all affects the absolute integrity or uniform action of this lonely, faithful light doing its whole duty always like a disciplined soldier, under any and all conditions.

The writer is glad, while testifying to the skill and ingenuity of French engineers, to state that our own government employs in its lighthouse service some of its brightest and best educated engineers, who are engaged constantly in studying the methods and inventions of other countries and successfully designing the most beautiful and suitable appliances and mechanisms to meet the wants of commerce.

The writer is specially indebted to Capt. John Millis, United States Engineers, Secretary of the United States Lighthouse Board, and to Mons. F. Guillain, Directeur des Routes et Navigation of the French gov-

60 passengers, but when fully loaded it was found that the deformation of the rubber tires added to the resistance. After a few months the experiment was discontinued, but Thomson's road steamers were destined to be made in numbers.

A steam carriage made in 1862 by Mr. A. Patterson must here be noticed. It is illustrated by Fig. 27,‡ and is still in existence, though incomplete, the engines having been taken out when the red flag act of 1878 came into force. The boiler and engines were carried on a circular frame with a flange at the bottom. A corresponding circular ring in the frame of the fore part of the carriage served to connect engines and carriage and allowed the engine and boiler to turn on the front pair of wheels, which carried the whole of their weight. A circular rack on the first mentioned ring and a pinion provided the steering gear. One driving wheel could be thrown out of gear by a clutch; the other had a friction clamp lined with wood with sufficient grip of the driving shaft to assist in driving and yet allow for turning corners. The cylinders were 3 in. diameter, 6 in. stroke, and drove by spur gearing. Water was carried under the back seat and fuel underneath side seats. The working pressure was 100 pounds, and the weight in working order was about one ton.

In 1871 a self-contained steam omnibus was brought out by Nairn, and ran four months between Edinburgh and Portobello.§ It was named the Pioneer, and its history, however, was one of failure, from causes common to the failure of many. At the rear of the omnibus were three cylinders, 7·5 diameter and 10·75 stroke, coupled direct to 3 ft. 4 in. driving wheels. The boiler was a combination of water and smoke

* From the Journal of the Society of Arts.

† "Improvements in carriage wheels." No. 10990, Dec. 10, 1845.

‡ The Engineer, Nov. 22, 1895, p. 505.

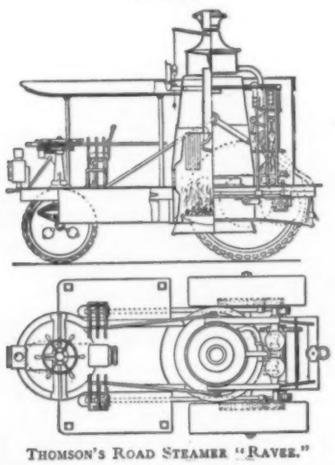
§ "Steam Locomotion on Common Roads," J. Head, "Proc. Inst. Civ Eng.," vol. xxxvi, 1873.

tubes, with only 2 ft. grate surface and 120 square ft. of heating surface. The chimney passed to the rear under the seats of the outside passengers and discharged the smoke and exhaust over the conductor's head, the exhaust being regulated by a cone and screw. In front, the omnibus was carried on a single 3 ft. 4 in. wheel in a fork. The omnibus was carried over the main axle by leaf springs, 4 ft. 6 in. long, supplemented by pendant volutes and India rubber washers 4 in. thick. Over the leading wheel were four volutes and rubber washers. The weight, with coke and water, was 7 tons 8 cwt., and with 50 passengers 10·5 tons. During the four summer months of 1871 this is said to have run the three mile journey from 11 to 12 times per day, carrying an average of 21 passengers, and making in all 952 runs. At the end of this, however, the whole of the working parts had practically to be renewed, the wear being so great in consequence of the admission of dust and mud to all bearings and rubbing surfaces. The wheels being only 40 in. in diameter, the cylinders and all connections were necessarily very near the ground, and the experience was the same as that with most steam tramway engines, it was impossible to keep the working parts in order. The dirt from the chimney, although ejected at the rear, was a source of great annoyance, and, with dirty seats, a hot part near the boiler, steam from the glands coming up through the floor, the cost of repairs and diminishing support, it was found best to discontinue the running. It seems curious that 35 years after the success of Hancock, who had found the means of avoiding nearly all these causes of failure, this experiment should have been so unsuccessfully made.

Hancock's coach, however, for 16 passengers, weighed 3 tons 12 cwt., which is a greater weight per passenger than that of Nairn's Pioneer, and there is little doubt Hancock's coaches were rather noisy and rough riding. His boiler was, however, better suited to the purpose, the whole of the working parts effectively inclosed, and the greatest trouble was the wear of the tires of the driving wheels. It is, perhaps, probable that had Hancock's coaches run a longer time, more troubles would have arisen, the chain he used for driving and the sprocket wheels would probably have worn, but as they were large-featured and strong, they would probably have worn a good deal before needing renewal, and they secured the separation of the engine from, and its higher speed than the driving axle, which was advantageous.

But to return to Thomson's road steamers. The first and leading idea in these was the use of heavy solid India rubber tires. The engines using them were mostly fitted with vertical boilers with Field tubes,

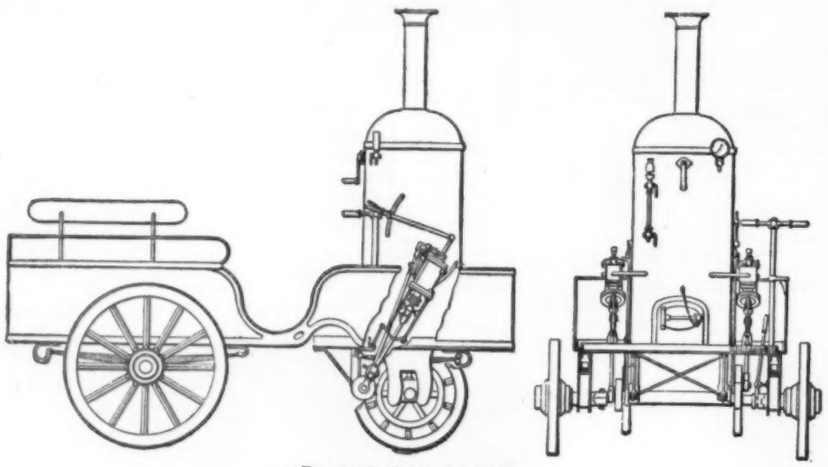
Fig. 28.



Thomson's Road Steamer "Ravee."

and with vertical engines, but some of other types were made. They were, however, all of them more of the traction steamer than steam road carriage. They were made by Messrs. Ransome, Sims & Jefferies, Messrs. C. Burrell & Son. Messrs. Robey & Company, and Messrs. Tennant & Company.

Fig. 27.



Pattison's Steam Carriage.

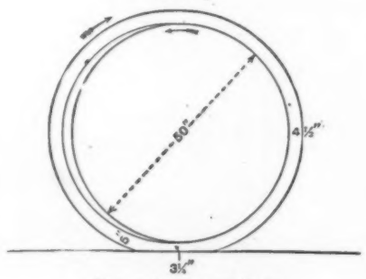
Fig. 28 shows, in sectional elevation and in plan, the 14 horse power Thomson's road steamer Ravee, one of four built by Messrs. Ransome, Sims & Jefferies for the Indian government, in 1871. It had two cylinders 8 in. diameter and 10 in. stroke, geared both 3·75 to 1 and 12 to 1, to 5 ft. 2 in. driving wheels, fitted with solid rubber tires 10 in. by 5 in. thick, protected by linked steel shoes. At 150 revolutions per minute the engines gave a speed of ten miles per hour, or of three miles per hour for the slow speed. The boiler was on Olrick's pot Field system, with 177 square feet of heating surface and 11 square feet of grate surface. The single leading wheel was also fitted with a rubber tire, but a double leaf spring was also here used. The engines were used to draw two-wheeled omnibuses carrying 65 passengers and mails between two stations in the Punjab, seventy miles apart. Mr. R. E. Crompton, then Lieut. Crompton, took these engines over and was responsible for their running for some time.*

Numerous experiments made with engines of this class, fitted with Thomson's wheels, showed that they could haul an unprecedented load in comparison to their own weight, and, correspondingly, could ascend inclines previously insurmountable. Experiments made by Mr. (now Dr.) William Anderson gave a coefficient as high as 0·576. A 6-ton engine took a load up an incline of 1 in 9, 20 tons up an incline of 1 in 20, and took itself up a grass slope of 1 in 4·5. A 7-ton engine, with 5·5 tons on the drivers, was tested by drawing a dead weight over a pulley. On good ground it gave a pull of 63 cwt., giving the coefficient of 0·576, and it gave a pull of 51 cwt. on a less favorable surface, or a coefficient of 0·466. These figures were afterward confirmed by the Royal Agricultural Society trials at Wolverhampton in 1871, when the average coefficients for iron tires and rubber tires were found to be respectively 0·5 and 0·3 on dry macadam roads.

A somewhat similar engine to the Ravee, but named the Sutherland, was tested at the trials mentioned, with results which showed the high tractive efficiency of road steamers fitted with rubber tires. It was the Ravee which made the longest journey ever made by a self-moving engine, namely, from Ipswich to Edinburgh and back in October, 1871, the engine and carriage it hauled weighing 19 tons.

Messrs. Burrell & Sons made 3-wheeled road engines with Thomson's rubber tires, locomotive boilers, and with spur gear, as in ordinary road locomotives; and many were sent abroad to haul omnibuses. The cost of renewal of the India rubber tires was, however, too great for continued commercial success of the system. A set of three tires, such as those used on the Ravee, cost £241. The tires were loose upon the iron rim, and as this was flanged, the tire had to be stretched or sprung over the flange to get it on. In working with the heavy weight of these road steamers, the rubber was pressed out as shown in Fig. 29. Under the load

Fig. 29.



Thomson's Rubber Tire.

the 5 in. tire was squeezed to 3·25 in., and as the wheel rolled along, not only was the rubber pressed out in advance, but it became closely adherent and stretched tightly on the rear of the wheel, the thickness being reduced by this to 4·5 in. while it resumed its normal thickness in the front. At eight miles an hour the squeezing and stretching of the tire was such that it left the wheel in the manner shown by a distance of about four inches. From this action the rubber tire was continuously rotating round the wheel in a reverse direction, making a complete revolution rearward to every 30 to 40 forward revolutions of the wheel. It will thus be seen that the rubber was very heavily worked and rubbed, and hence gradually reached a condition in which it lost its strength and broke. The linked steel shoes prevented this to a considerable extent, but so strong is the tendency to the creep referred to, that even when the rubber ring was placed between the wheel rim and an iron exterior tire, on Adams' system, the link connecting the outer tire to the inner rim was frequently broken, and it was difficult to keep them connected. This was also the case when the rubber was used in blocks.*

These facts give some idea of the difficulties connected with the use of solid rubber tires under heavy loads, and it is rather curious that Thomson, having invented the pneumatic tire, did not make some efforts to develop it into a form suitable for light road steamers, so as to get some of the spring from compressed air instead of all from soft rubber. With the pneumatic tire the rubber would not be "worked" so injuriously as in the solid, and the cost would be much less. The insistent load of the Ravee, and such engines, was too great for any solid rubber tires, except of very large section, and then the expense of the wheel complete was prohibitive. Messrs. Burrell have, however, successfully used such tires of large width, as will be seen hereafter.

It may be remarked, in passing, that although almost innumerable attempts have been made during the past twenty-five years to produce a satisfactory metallic spring wheel, none have been permanently successful, and the best traction engine wheel to-day is the Bolton wheel, with wood blocks in pockets of the outer tire. Some of the spring wheels made by Aveling, Fowler, McLaren and Burrell have promised well, but all have in their turn been given up in favor of spring-mounted engines, the best being leaf springs. In running the "Fourgon Postes," between Lyons and Grenoble, doing 500 miles per week, and in high speed traction tram work over long distances with bad roads and no roads, and over the Southern Alps,† Messrs. J. and H. McLaren had unique experiences with spring wheels, springs of all kinds, and rubber springs. In France the whole of the running was done under time penalties, and in all weathers, and all experience went to prove that only leaf springs would stand when rigid wheels were used and that spring wheels were for this heavy work unsatisfactory. In one set of engines rubber buffers were used over the main axles in addition to volute and Timmins' springs, but it was found that the occasional leakage of oil into the rubber buffer box and the working of the rubber under the load would, after a few days' use, cause the rubber to spue out of the air hole in the box in the form of rubber ropes. These engines ran for several months, including winter, at from 8 to 15 miles per hour, including the crossing of several spurs of the French Alps with variable gradients, including one of 1 in 10. They were fitted with gas head lights and side lamps, each engine carrying a receiver sufficient for the double journey and carrying its own gas compressing pump. Petroleum lamps were tried, but were frequently put out by the vibration of the engine at the high speed. Much of the experience with these engines was of a nature that would only arise with the heavy form of high speed locomotive, but on the other hand, many of the lessons learned were not without high value in connection with lighter mechanically propelled vehicles on common roads.

The same may be said of the very lengthened experiences of Messrs. Burrell & Sons, and reference may be made in particular to a pair of traction engines similar to that shown in Fig. 28, but afterward fitted with wheels with wide tires and iron exterior shoes. They were built in 1871 for the Harrogate Gas Company, and one of them is at work to the present time, having been recently replaced by one of Messrs. Burrell's spring-mounted engines weighing 10 tons, and capable of hauling 30 tons. These are fitted with arrangements for three speeds, the highest being obtained by means of a high speed second motion shaft driven by an internal ring of teeth within the flywheel rim. A raw hide pinion is driven by this internal geared flywheel, and the shaft which carries it runs with roller bearings. This arrangement is the subject of a new patent, and appears to secure a third speed with very little additional gear. The driving wheels are fitted with rubber tires, and the boiler is carried over the two front wheels by means of a strong leaf spring of locomotive type. Each of these engines travels thirty miles per day all the year round. The steering is effected by means of a spur wheel on the fore carriage, into which a pinion on a vertical shaft passing through the smoke box gears. On the top of this spindle is a worm wheel with a worm worked from the foot plate. A very rigid steering gear is thus obtained, and one which is certain in its action.

All these engines are of what I have termed the steam cart horse order, and they show the direction in which development has chiefly taken place in the past quarter of a century. The engineers who have been engaged in their construction will perhaps be in the best position for interpreting the experience afforded by this class of road locomotive construction, and no doubt some of them will be early in the field as makers of the light mechanical road carriages for which it is expected there will soon be a considerable demand. The difficulties, however, connected with a radical change in design, in the departure from one line of development to another, are of a kind which are sometimes more easily surmounted by those who minds are unfettered by a knowledge of all the reasons which have led to adopted forms. The road locomotive builder has had to deal with heavy loads, heavy engines, and with conditions calling for vast strength. He has had to make an engine which is practically unbreakable under the severest conceivable conditions, and it will be easily seen that to turn from this sort of thing to motor carriages in which sufficient strength can be gained with the lightness of the parts of a brougham on the one hand or of a street omnibus on the other, will be a mental feat of no small difficulty.

* "Proc. Inst. Mec. Eng.," August, 1879

*A large number of different forms of elastic wheels have been made, some of which were described by Head, "Proc. Inst. Civ. Eng.," vol. xxxvi.

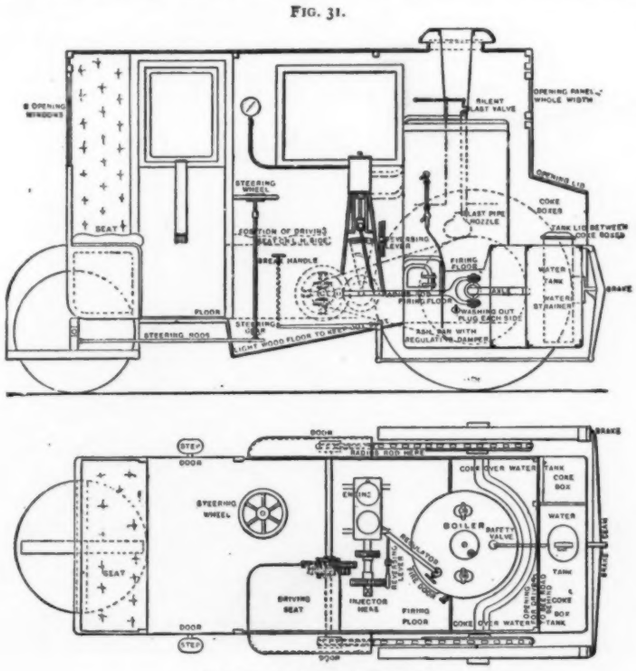
† The New Zealand Farmer, September, 1895, p. 223. "Proc. Inst. Civ. Eng.," paper on "Steam on Common Roads," by J. McLaren, vol. cili.

Among the departures from the line of development just referred to, a steam carriage made in 1866-7, by Mr. H. Percy-Holt, may now be described. It is a carriage which contains several features of interest in connection with the construction of a light road vehicle. It was carried on three wheels, the driving wheels being 4 ft. 6 in. in diameter and the front wheels 2 ft. 6 in. in diameter. At the rear of the carriage, the frame of which was formed of light angle iron 3 in. by 3 in., was suspended a Field boiler 4 ft. in height and 2 ft. in diameter at the upper part, with 50 ft. of heating surface and 3 square feet of grate surface. This supplied steam at a pressure of 250 lb. to a pair of engines consisting of four cylinders. Each pair of cylinders was 3 in. diameter and 6 in. stroke, the pistons being connected to two separate crankshafts, on the outer ends of which were pitch chain pinions 8 in. in diameter connected to pitch chain wheels, 24 in. in diameter, on the drivers by two separate chains. The cylinders were disposed as shown in the plan and at an angle as shown in the elevation, the whole of the machinery being boxed in, including two feed pumps worked direct from the crossheads. The exhaust from the engines passed into a cast iron box which formed a baffle plate at the bottom of the uptake above the fire where it was superheated. It then issued in five continuous jets up the chimney. This arrangement, owing to the large number of beats from four cylinders, made comparatively little noise. Part of the exhaust was used to heat the feed water when required. The feed pumps were of novel design, the plunger uncovered a port near the end of its outstroke through which water was admitted from a water tank above it. On the return stroke this suction port was covered by the plunger and the water forced through the delivery valve into the boiler. The carriage complete weighed, in running order, about 30 cwt. and carried from six to eight people, including the steersman and engine and boiler attendant. It ascended gradients of 1 in 14 at about seven miles per hour easily, and on ordinary roads ran from fifteen to twenty miles per hour, and was thus much more powerful than will be required for the moderate speed vehicles of the future. The safety valve used was of the Naylor type, two inches in diameter. The bunkers carried sufficient coke to run about forty miles, and the tanks would hold water for about twenty miles, the coke consumption being about 5 lb. per mile under favorable conditions.

The steering wheel was worked by a vertical shaft and cross bar connected at the bottom of the former by a beam and a pair of rods connecting it to the table supporting the steering wheel bearings. The reversing levers for the two pairs of engines could be grasped either separately or together, ordinary link motions being used, working valves in a steam chest between the two cylinders. Each pair of engines, being independent, could be used with the reversing gear as a brake, and the very great advantage of the independence of these engines was the smoothness with which they suited the speed of the wheels in running round corners and made any form of compensating gear unnecessary. A further advantage was that of being able to use on good level roads only one engine, or to link it up so that very little steam was used. The water tanks were arranged on each side of the steering wheel, and the coke bunkers on either side of the boiler. The greater portion of the weight was carried on the driving wheels, which were of usual omnibus pattern, of wood, with 3 in. iron tires. The chain wheel was fastened to the wood spokes by clips. The rear part of the carriage was carried on large leaf springs. It was built at Headingly, near Leeds, and used by Mr. Holt for some time.

Another vehicle of very considerable interest now is the steam brougham illustrated by Fig. 31. This was

FIG. 31.

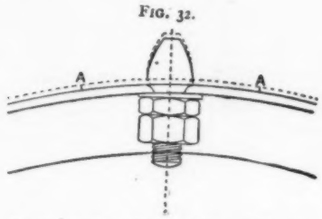


MACKENZIE'S STEAM BROUGHAM

a three wheeled carriage, built in 1875-76 by Mr. H. A. O. Mackenzie, at the rear of which was a Field boiler with about 34 square feet of heating surface and 1·76 of grate surface; it was 4 ft. high and 2 ft. in diameter. The engine was a two cylinder vertical, driving by one or other of two spur wheels of different sizes a second motion shaft in the center of which was a compensating gear, and on the ends of which were pitch chain pinions, on which, and on toothed rings on the road wheels, ran two pitch chains, the ratio of engine speed to road wheel speed being 6 to 1 and 13 to 1.

The driving wheels were 4 ft. in diameter. The boiler pressure was 135 lb.; and, as fuel, foundry coke was used. The boiler was large enough to give considerable reserve capacity, so that on the one hand the water level need not for a few minutes be a cause of anxiety, when road matters were occupying attention, and, on the other, steam did not begin to blow off immediately a stop had to be made. The engine cylinders were 3·75 in. by 4·5 in., and an ordinary link reversing motion was used, with which Mr. Mackenzie used to drive, rather than with the regulator. It was found that one change of speed was sufficient for all purposes, intermediate variations being easily obtained from the engines; and, in fact, Mr. Mackenzie considers that a change gear may be made unnecessary by using cylinders of somewhat larger diameter. For this reason he did not provide any lever arrangement for changing the position of two gear wheels, shown on the crank shaft, but used simply a broad cylinder of leather, stiffened with ¼ in. rods, and encircled by a small buckled strap. When both wheels were out of gear, as shown, this leather cylinder was between them. When either of the wheels was put into gear, this leather collar was taken off, the wheel pushed into gear, and the collar put on behind it. This arrangement was pending experience as to the necessity or otherwise of change of speed by gearing. When the larger wheel on the crank shaft was in gear, the speed of the carriage was from 10 to 12 miles an hour. The gear wheels on the counter shaft had wood teeth, to avoid noise, and the driving wheels ran loose on the main axle, which was bent, to escape the boiler, as shown.

FIG. 32.



MACKENZIE'S CHAIN WHEEL TEETH.

The wheels were ordinary wood carriage wheels with iron tires. Mr. Mackenzie found the Field boiler very satisfactory, as it gave him plenty of reserve power for emergencies and to meet the varying requirements of the road. The water in passing into the water tank passed through a strainer, a necessary precaution for a boiler which may have to take water from ponds and streams. The boiler was fed by an injector, which was probably the first so used. The exhaust steam from the engine passed into a cast iron pot at the bottom of the uptake, from the center of which issued up the chimney. A blast valve was also used and opened a notch or two when the road did not require a strong blast, the valve acting as a variable blast, and enabling the rider to occasionally reduce the back pressure in the cylinders. Radius rods shown in the elevation connected the chain pinion bearings to the axle close to the boss of the driving wheels. These maintained the proper distance between the chain wheels. None of the machinery was visible from the outside, but everything was accessible inside for experimental purposes. The brake tackle was fitted after the carriage was made, as it was intended, in the first instance, to brake by means of the reversing lever only. To allow for and compensate for the chain wearing out of pitch, the chain wheel was fitted with teeth as shown in Fig. 32. The teeth, of the form shown, were held in the toothed ring by a pair of nuts on a screwed stem, and when it became necessary, the diameter of the ring was increased by putting thin strips of iron under each tooth as indicated by the dotted lines, A A.

In the constructor's hands this carriage was found quite satisfactory, but the road locomotive act forced him to discontinue its use.

The carriages by Mr. Holt and by Mr. Mackenzie both present numerous points of considerable interest, but it will be observed that the boiler and machinery are in both cases apparently too much the reason for the existence of the whole vehicle. There is no doubt, however, from what they have done that they would be able to modify their design in accordance with what we may assume to be modern requirements.

In 1878 a mechanically propelled dog cart was made by Mr. A. B. Blackburn.* It was propelled by a small three cylinder torpedo engine which drove a transverse second motion shaft placed under the foot board of the dog cart, on one end of which was a grooved pulley over which ran a gut belt driving a grooved ring attached to one of the rope wheels acting as driving wheel. The torpedo engine and the second motion shaft were fitted with coned pulleys, and a cross belt upon them enabled the engine to drive the shaft at variable speed. The engine was supplied with steam by a very small coiled tube boiler, described and shown in his specification, and heated by a benzoline burner. The benzoline was led into a vaporizer heated by warmed air, and by the exhaust. The exhaust from the engine passed into a condenser of tubulous form cooled by a fan, the condensed water being forced back into the boiler by a small pump. This dog cart is said to have worked successfully, but the road locomotive stopped it.

In 1870 Loftus Perkins made what may be called a steam horse, for attachment to the front of any vehicle. In it the engine, boiler, and driving gear were all mounted on circular frame carried above a single wheel, with which all turned in steering, as described in the reference to Fig. 27. The wheel was 25 in. by 12 in., fitted with a Thomson rubber tire 5 in. by 10 in. The engine was a compound with two cylinders 1¾ in. diameter and two 3½ in., all with a stroke of 4 in. He carried a pressure of 450 lb. in a Perkins tube boiler, 26 in. high, 15⅝ in. wide, and 20⅜ in. long. The engine ran at speeds up to 1,000 revolutions per minute, and drove the rubber tired wheel by bevel gearing. The weight of the steam horse was 32 cwt. It was sent to Belgium, and its fate is unknown.

The steam from the engines was passed by a pipe to a condenser connected with a water tank under the vehicle it hauled, which, in Perkin's experiment, was a light van, and weighed, with a number of passengers, 57 cwt. A trial run to St. Albans and back gave a coal consumption of 2·17 lb. per ton mile. The average steam pressure used in its engines was 250 lb., another average speed was three miles per hour. The grate surface of the boiler was 0·75 sq. ft. The very high pressure, the kind of boiler, and the very small engines are points of interest. Mr. Perkins also made a tramway engine with his high pressure engine, and a boiler similar to that used in the celebrated yacht Anthracite, and with an air-cooled tubulous condenser.

In 1881 Mr. J. G. Inshaw made a four wheeled steam carriage like a steam Irish car.† It was fitted with a tubular boiler, which supplied steam at 180 to 200 lb. to two cylinders 4 in. by 8 in. It had three speeds, double driving gear and reversing gear, and weighed 35 cwt. with 10 riders.

Reference should here be made to the electric dog cart, made in 1888 by Mr. Magnus Volk, of Brighton. In it a small Immisch motor, supplied with current from 16 small E.P.S. accumulators, drove a small second motion shaft under the foot board by a pitch chain, and from the other end, a chain pinion was connected to a chain wheel on one of the road wheels.‡

To several others reference must be made in the next lecture, as well as to the direction which the development of motors has taken. Sufficient has been said to show that, but for some impeding cause, the construction of mechanical road carriages was so far advanced as to have reached the commercial stage. There can be no doubt that the chief hindrance was the existence of the highways and locomotives acts, directed chiefly against the use of traction engines and road locomotives, and even against agricultural locomotives. But the existence of these acts shows that the country was not alive to any requirements of mechanical carriages, and, with the acts in force, every attempt was discouraged, and nothing sufficient to encourage the country to demand relief could be done by steam carriage designers.

But we have seen what the Hancock period arrived at, and what the intermediate period, down to 1885, or fifty years, has done. We have seen that while British makers have made carriages and worked them successfully abroad, and have made many hundreds of high speed road locomotives for foreign purchasers, they have been unable to use them in their own country. We have seen that while English engineers have paved the way for the construction of steam road carriages, it is not until foreign engineers, taking advantage of their freedom and of our teachings, have begun to reap the harvest we have sown, by the free use of motor carriages, that our country begins to support our engineers. However, it is known now, and the time appears to have arrived when the industrial importance and the useful applications of mechanically propelled road carriages are understood. People now see the necessity for a change in our laws, so that light motors or motor carriages and vans of moderate weights and of moderate speed may be freely used here as they are abroad, and I hope that the necessity for securing the support in Parliament of the proposed bill for this purpose will be generally realized.

We can hardly say that the small progress made in this country since the time of Hancock was the result altogether of obstruction laws, for the worst features of these laws are comparatively recent. The country was not ready, and our forefathers sought only to establish high speed vehicles. They thus ran counter to

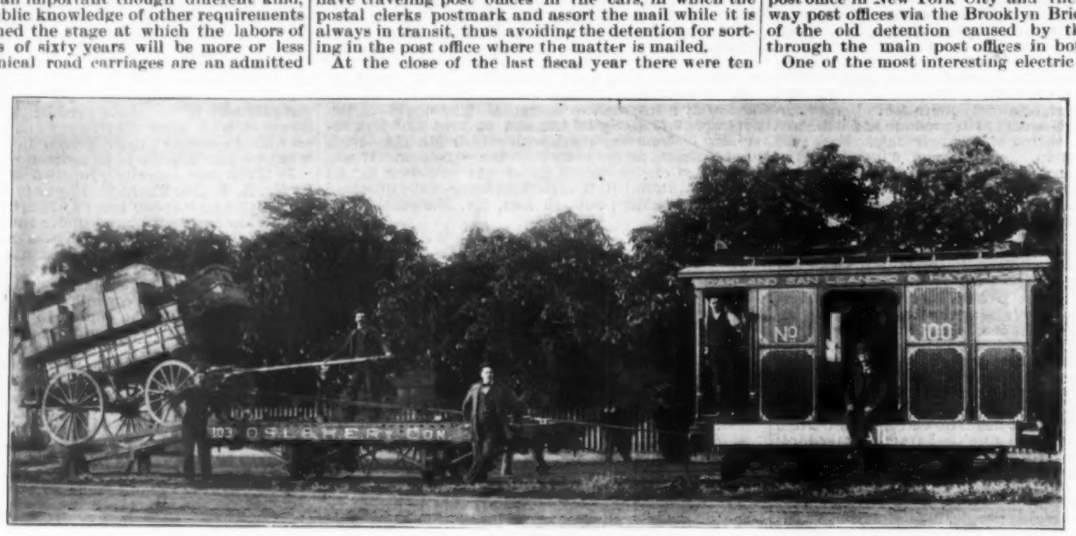
* The Field, November 23, 1878, Patent No. 3838 of 1877.

† The Engineer, November 1, 1895, p. 434.

‡ The Engineer, February 3, 1888, p. 98.

powerful interests, and high road speeds were not really wanted then and are not now.

Those who followed have filled up time between the days of absorbing interest in railways and the present by inventions of an important though different kind, and growth of public knowledge of other requirements has at last reached the stage at which the labors of all these workers of sixty years will be more or less utilized. Mechanical road carriages are an admitted necessity and public interest in manufacturing concerns will now encourage builders, instead of leaving them single handed to fight through difficulties and unappreciated success as it did Trevithick and others.



LOADING AN EXPRESS TROLLEY CAR.

SOME RECENT DEVELOPMENTS OF THE TROLLEY.

The development of the electric railroad is no less remarkable in the direction of the transportation facilities offered than in the extension of line, for now the trolley is not only used for urban and surburban passenger transportation, but we have had within the last two years examples of the advertising trolley car, the trolley sprinkler, the excursion car for summer use, and the parlor car for winter use, the floral car, the funeral car, the mail car and the express or freight car. We present some engravings of the electric railway mail and express cars, and of an electric trolley snow plow.

On June 30, 1895, there were in operation in the United States 82 street railway mail routes, covering a distance of 573 miles. These lines were performing a daily service aggregating yearly 1,144 201 miles of travel with closed mail pouches carried from one post office to another. The magnitude of this particular class of service is shown by the fact that these lines carried each day 1,856 pouches of mail matter.

The higher development of the work, however, is to have traveling post offices in the cars, in which the postal clerks postmark and assort the mail while it is always in transit, thus avoiding the detention for sorting in the post office where the matter is mailed.

At the close of the last fiscal year there were ten railway post offices of this kind in operation, of which seven were in Boston, one in Brooklyn, one in Philadelphia, and one in St. Louis.

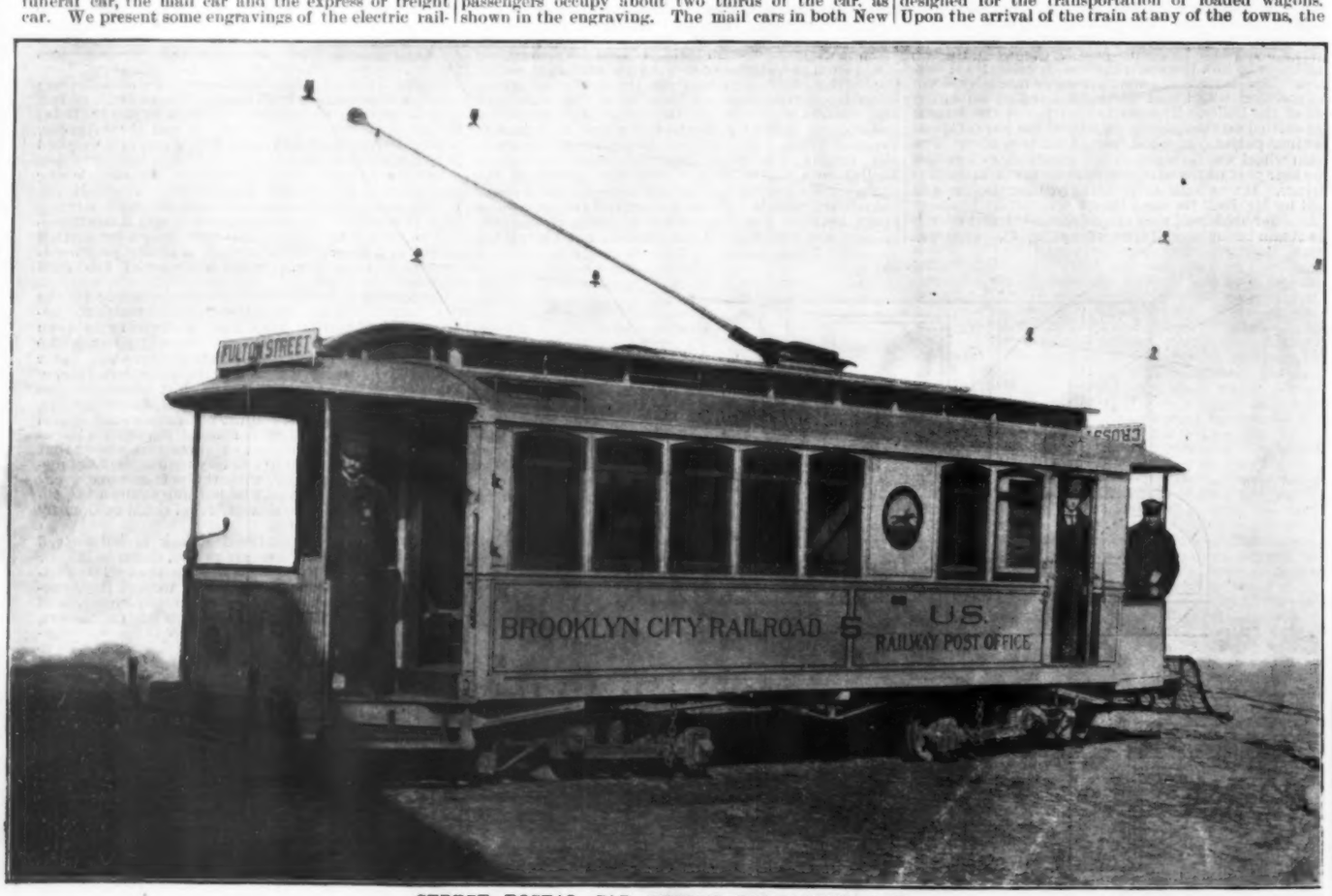
Brooklyn has now four street railway post offices as well as two other street car mail lines carrying closed mails. The railway post offices run: First, from the general post office to Coney Island; second, from the general post office to Long Island City; third from the general post office to East New York via Fulton Street; and fourth from the Broadway Ferry to East New York via Broadway. All branches of the Brooklyn post office are connected by these lines, and the service is hourly.

The cars in use in the New York service are devoted entirely to post office business. The cars in use in Brooklyn are known as comparted cars; a compartment at one end being used for the mail service while passengers occupy about two thirds of the car, as shown in the engraving. The mail cars in both New York and Brooklyn are painted white. The clerks employed in these cars are appointed in the railway mail service.

In Brooklyn the cars are lighted and heated by electricity and the seats resemble those in the ordinary railway car. A partition separates the passenger section of the car from the mail section. Stamps in small quantities are sold through a small window and letters may be posted en route from the inside or outside of the car. There is now a direct interchange of mails between the Third Avenue Railway [cable] post office in New York City and the Brooklyn Railway post offices via the Brooklyn Bridge, without any of the old detention caused by the mails going through the main post offices in both cities.

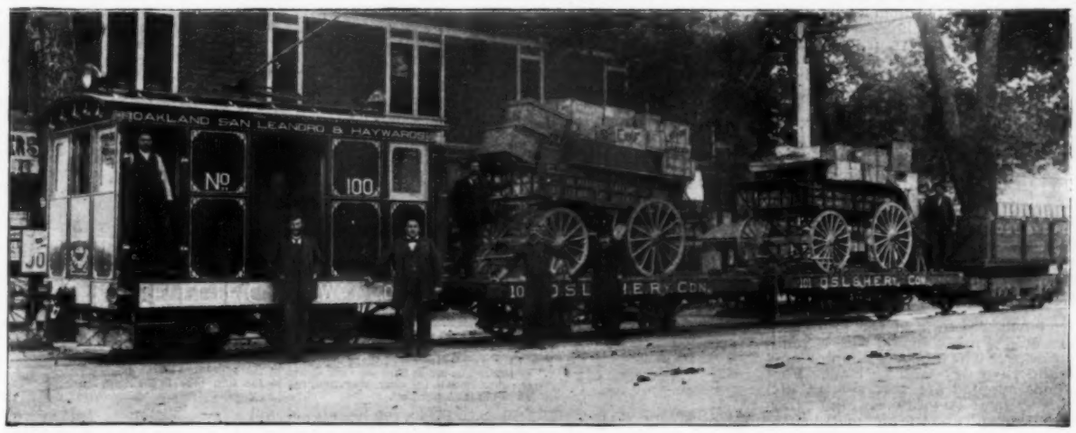
One of the most interesting electric railway express services is the system of the Oakland, San Leandro & Haywards Electric Railway, consolidated, operating an express trolley service between Oakland and Haywards, a distance of about seventeen miles. The line passes through a number of towns, including East Oakland, Fruit Vale, Melrose, San Leandro, etc. Between San Francisco and Haywards the express business was formerly carried on by means of wagons drawn by horses. This method was comparatively slow.

The system is now operated as follows: The company stations wagons in San Francisco, seven miles from Oakland. During the day these wagons gather up the parcels and bring them to the depot. They are then loaded in heavier and larger wagons which are transported by ferryboats to Oakland. Upon arriving at Oakland horses are used to transport the wagons to the waiting express train, which is specially designed for the transportation of loaded wagons. Upon the arrival of the train at any of the towns, the loaded wagons are taken off from the cars and their contents distributed in the ordinary way. The motor car is eighteen feet over all and weighs eleven tons. The car is equipped with two motors, and is also provided with the duplex pump driven by a two horse power motor for actuating the air brakes with which all the cars on the train are provided.



STREET POSTAL CAR SYSTEM—COMPARTED CAR.

The car is supplied with sand boxes and can pull a load of over thirty tons over a five per cent. grade with greatest ease. It will be found desirable to give the car an outward appearance like the passenger cars of the line, as in this way it will invite less criticism on train passing through the principal business streets. The cars behind the motor car are of the ordinary flat car pattern and are painted in tasteful colors. The wagons are loaded on these cars by causing the motor to pull the same upon the car by aid of ropes and skids, as shown in the accompanying engraving. One wagon is placed upon a car and is secured by means of clamps. The train takes up and discharges express matter along the route, and the motor car is sometimes used for express matter.

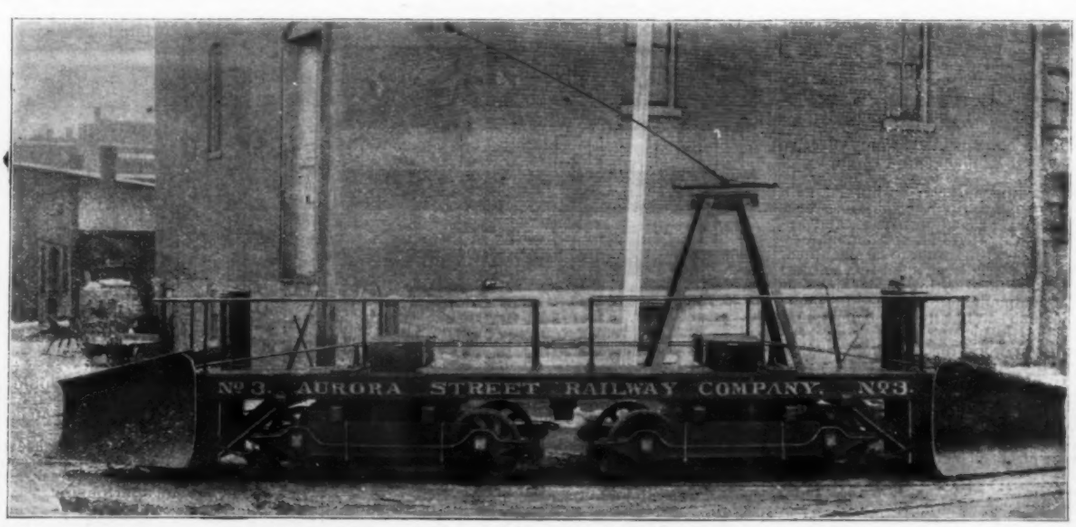


EXPRESS TROLLEY CAR LOADED.

The motor car also hauls seven ton coal cars. In the summer the motor car is used to handle large picnic crowds, special open cars being provided for this purpose. Regular passenger cars are also operated upon the line. All of the cars are equipped with air brakes.

The electric snow plow is, of course, a necessary adjunct to the trolley road.

D. A. Belden, manager of the Aurora Street Railway, has been able to provide his road with an efficient snow plow at a very nominal cost. A pair of noses with lifting mechanism was purchased from the Taunton Locomotive Manufacturing Company. These noses are such as are used on that company's heavy plows. The frame of the plow was then built so as to be adapted to them. In order to gain weight and power, two discarded 40 horse power Detroit bevel gear motor equipments were selected and a separate framework of heavy timber was built for each. Each motor and truck was connected with the main frame by heavy king bolts and turning plates. Each truck thus swivels and takes curves without difficulty. The motors are operated by series parallel controllers, and by reason of both axles being geared to a single motor good traction is obtained. The entire length of the plow is 40 feet, and the weight something over 16 tons. The noses alone weigh 2,000 pounds each. The noses are raised and lowered with a crank and gear movement operated by wheel and staff, and are connected to each other with equalizing rods running the full length of the plow, so that the weight of one plow helps to raise the other. Otherwise the noses could hardly be operated by one man. Heavy cast iron diggers are used provided with raising and lowering mechanism and heavy springs to permit of passing bad joints and special work with safety. The upper frame work is made very heavy and strong, two 8 by 10 inch outside timbers being used, 29 feet long, and two 6 by 8 inch timbers, 31 feet long. Truss rods prevent the weight of the noses sagging the frame work. Four detachable wings, two to each nose, are used when required, but are not shown in the photograph. The plow has been found very effective, the two 40 horse power motors furnishing ample power to move any quantity of snow that it has ever been called on to handle. In double track districts the nose plow is, of course, not as desirable as a shear plow, but where there are double tracks the "Walkaway" horse plow follows the electric and moves the snow from the inside. Everything about the plow is built for strength, and any likely obstruction would probably give way before the plow was injured. Being a nose plow, there is of course no tendency to leave the track, as with a shear plow, and it can be run at a higher speed, consequently covering more territory in a shorter space of time. As a great deal of the Aurora system is single track, the plow is well adapted to the service it is used in. Its cost complete, not including motors, was $600. For our engravings of the trolley express and snow plow and the foregoing description of them we are indebted to the Street Railway Review. Our engraving of the Brooklyn mail car is from a photograph made by the special artist of the SCIENTIFIC AMERICAN.



SIXTEEN TON HOME MADE SNOW PLOW AT AURORA.

DEFECTS IN IRON CASTINGS.*

By D. BROWN, Wh.Sc.

IT is a well known fact that a great many of our best achievements in engineering, as well as other professions, are based on the experience and knowledge gained from failures in previous similar undertakings.

In no branch of engineering is this more impressed on one than in founding, be it either brass, iron, or steel, and the successful founder of the present, as well as he of the past, is the man who studies well his bad castings, to find the cause of their defects, and from the results acquires the knowledge requisite to show him the best means for their prevention in future.

He cannot plead want of opportunity, for the reasons of failures in castings seem so multifarious and varied that it is impossible at any time to avoid a certain percentage of bad castings, especially in a foundry doing a variety of work. The first defect we will consider is a very common one; it is the presence of blow holes in castings.

These are due to a variety of causes—damp sand, defective cores, want of proper venting, and the fact of risers, or flow gates, as they are sometimes termed, either being too small or not properly situated. It will be readily understood that when the melted iron comes in contact with any damp sand, steam and other gases are formed, which in many cases, not being able to escape from the mould, occupy a certain amount of space to the exclusion of the metal, and, of course, forming recesses or holes, which are very detrimental to the strength or appearance of a casting. One very aggravating characteristic of the holes is the fact that they cannot be detected in some cases until the casting has been machined, which, of course, means a loss of time in addition to the loss of the casting. To avoid this, the moulder requires to be very careful about the damping of his sand, which is sometimes rather a difficult problem to solve, as on the one hand, if the sand is too damp, he has blow holes, while on the other, if it is too dry, and there are many sharp edges about the casting, the sand cannot be worked to a clean edge. Excessive dampness, or an accumulation of water, often leads to far more serious consequences than a defective casting. In casting large moulds into deep pits, great care has to be taken, as I have on more than one occasion seen explosions occur, although precautions had been taken to build a rough caisson round the pit.

This is a point which seems to be very little known among architects, who, almost without exception, specify all columns to be cast on end, no matter what their length may be. Where this is possible, there is no doubt it is the best way in which to cast a column or cylinder; but in Liverpool, where, in most of our foundries, water is found at no great depth from the surface, it is advisable to cast anything in the nature of a long column or girder on an incline, which is for most purposes as efficient as casting them on end.

The want of proper venting is one of the most common sources of errors in founding. A proper arrangement of vents is of vital importance in any kind of mould, but more particularly in a green sand than in a loam or dry sand mould. The arrangement of vents differs, of course, according to the nature of the form of the casting. Venting is performed by means of vent wires, which vary in diameter from ⅛ inch to ½ inch, and from 12 inches to 4 feet long, the smaller ones having an ordinary wooden file handle and the larger a cast iron T handle.

To illustrate the process of venting, it might be better if I took one or two examples. We will suppose that we have a pattern in the sand which is not very large or heavy; when the top part is rammed up and ready to be lifted, then the small vent wire is used all over the top part, passing through the sand till it reaches the pattern. The top part being then lifted off, a small channel is cut with a trowel all round the pattern and 2 inches or 3 inches from it; then the vent wire, bent so as to pass under the bottom of the pattern, is freely used round this channel, which is intended to connect all the vent holes. Branches are cut from this channel so as to lead all gases away clear of the top part. In larger moulds these vents are made before the top part goes on, and the channel cut 3 inches or 4 inches from the surface. Straw ropes

* Abstract of paper read before the Liverpool University College Engineering Society, November 26, 1895.—From the Iron and Coal Trades Review.

and ashes are then laid in the channels, with branches, as before. These are then covered with sand and the joint of the mould made up. The reason this arrangement is made is to avoid the possibility of metal getting into these channels and choking them if the top part should happen to rise. Castings that have a recess or chamber on the under side have to be very carefully vented. We will take an H girder for example. The usual way of venting such moulds is as follows: The pattern, being turned bottom up, is filled with sand, rammed up, and then vented. It is then turned over and bedded in the usual way, after which a bent vent wire is used, so that we have vent holes connecting with those already there. The top vents, of course, are made straight through the top part.

In the case of a very large or heavy casting, where the side vents as described would not be capable of affording a ready escape for the gases generated in the bottom of the mould, the method of venting is different. A hole being dug out in the sand a little deeper than necessary for bedding, the pattern is covered all over the bottom with a layer of ashes 4 inches or 5 inches thick. The pattern is then bedded down with a layer of sand, 3 inches or 4 inches thick, between it and the bed of ashes. Three or four tubes, about 3 inches diameter, are rammed up in the sand round the pattern connecting the ash bed with the surface, for the purpose of allowing the accumulating gases a free escape to the open atmosphere. Care is taken that the tops of these tubes are all clear of the top part of the mould.

When the pattern is withdrawn from the sand, the bottom part of the mould is freely vented with a vent wire to the bed of ashes. The above examples apply more to green sand than dry sand or loam. For dry sand the methods adopted are very similar, although not requiring as great attention, owing to the special preparation of the sand and the fact of its being afterward dried.

In loam moulding, again, the loam being made of open coarse sand, a vent wire is not nearly so often used, but straw ropes and ashes are freely laid in various parts of the mould.

Without going further, I think it will be quite clearly seen how important a thorough knowledge of venting is to a moulder.

Another source of blow holes already mentioned is defective cores, whose defects arise from a variety of causes.

Venting a core is of as much importance as venting the mould itself, and often is a problem of some difficulty.

Take the case of a hollow piston as they are generally made in cast iron for marine purposes. The core in this case is surrounded on all sides by metal, except at those places where the moulder and designer arrange between them to have a small branch through which to vent the core, and also to withdraw it when the casting is made. If left to the moulder, he would have a branch top and bottom; but in this case the engineer has to consider the probabilities of the plug that is afterward used to fill the branch coming out when the engine is working, and so causing a serious breakdown; and to avoid this the branch is generally made in the side. Cores that are not properly dried are a great source of danger to the casting, so that great care is taken with large, heavy cores to see that they are properly dried. Castings have often been found useless through an oversight affecting some part of the mould which seems of minor importance, although great care had been taken with the more important parts. This is often the case where there are many small cores in the casting.

If placed in the bottom of a mould, where there is a good pressure, they cannot do much harm; but if in the top, say round a flange, where they have been arranged to save drilling, then they require as much attention, to see that they are properly dried and vented, as do the large or main cores. The last cause of blow holes we will deal with is that due to the improper situation of risers.

The riser is an outlet through which escape all the air and gases contained in the mould at the time of casting, and which are, of course, displaced as the melted iron runs in. The proper position of a riser is naturally the highest part of the casting, unless that is where the runner happens to be placed. Should there be several high points, then there should be a riser for each, or there would be certain parts of the mould where air would be imprisoned without any means of escape. A riser is also of use to indicate when the mould is full as well as for feeding purposes, to which we will refer later. The question arises, Can blow holes in castings be remedied? The only effective remedy is burning, which is analogous to welding of wrought iron.

But it is not every casting that can be burned, as a great many of them, owing to their formation, crack, with the unequal expansion that takes place, and another thing, blow holes are often in a position inaccessible for burning. If the casting is not to be machined, and its strength is not materially affected by the blow holes, they are sometimes filled with what is known as "beaumontague," a compound of resin and borings; but this is a practice one can hardly recommend, and can easily be detected by heating the casting. Occasionally, in rough iron work for building or other purposes, deep blow holes are run in with lead, which is an unscrupulous practice, unless, of course, it is done with the engineer's or architect's consent. Expansion and contraction in their relation to moulding are very well understood as a rule by the majority of engineers, especially patternmakers; but there is one important point very often missed by patternmakers in making large core boxes for green sand castings, and that is an allowance for the expansion that takes place in the core while being dried in the stove.

I have seen a patternmaker very much perplexed on finding, when the core was put into the mould, only 3/8 inch metal, when he was sure he would have 1/2 inch metal. He checked over the pattern and core box (the difference between which represented 1/8 inch), but could find no solution to the matter until it was pointed out that probably the core had expanded 1/8 inch, which on trial proved to be the case.

There are in all seventy lines of cog wheel railroad in the world, with a total length of 500 miles, of which 188 miles are constructed on the Abt system.

THE STORY OF HELIUM.*

PROLOGUE.

DURING the last decade, as most of you know, our literature has been enriched by a recrudescence of the short story, generally dealing with very modern human affairs of various kinds, from many different standpoints.

But these modern stories and others that might be referred to are not the only ones now available. During the last sixty years Egypt, Babylonia and other countries which might be named, now here and now there, have supplied us with other stories—most precious indications which enable us to study, into a far reaching past, the beginnings of man's history. These stories, as you also know, were not very easily deciphered—they were all of them hidden away in strangest script, but the hieroglyphics and cuneiform characters, which at first seemed to have absolutely no meaning whatever, have, bit by bit, been unraveled by the genius of linguistic explorers, until at length we may say that the students of archæology are in possession of more or less complete histories of the most ancient peoples of the world.

All these histories have not yet been completely written, but my point is that they have been begun, and that even for the beginning of them the greatest skill has been required to transmute the strange hieroglyphics which were first employed by ancient peoples into modern equivalents, so that we can understand what they wished to convey. Here we are in presence of man's earliest attempt at any language; but the story which I, your president, have to tell you to-night has a very different origin to this, for the reason that, although it is a story, and written, it is true, in hieroglyphics, the hieroglyphics are of nature's invention and not man's.

The story or fairy tale of science, which has placed us in possession of the most precious truths regarding every star which shines in space, is a story written in nature's hireoglyphics in every ray of light which reaches this planet of ours from the tiniest star.

Now, of course, in the hour at my disposal to-night it is impossible for me both to tell you a story and spend much time upon the alphabet in which the story is written, but there are just one or two words about the alphabet that may be useful. One key to these hieroglyphics, this light story, which is hidden in every ray of light, is supplied to us by the rainbow, which teaches us that the white light with which nature bountifully supplies us in sunlight is composed of rays of different kinds or of different colors.

Many of you know that there is an almost perfect analogy between these colored lights and sounds of different pitches.

The blue of the rainbow may be likened to the higher notes of the keyboard of a piano, and the red of the rainbow, on the other hand, may be likened to the longer sound waves, which produce the lower notes; and as we are able in the language of music to define each particular note, such as B flat and G sharp, and so on, so in these celestial hieroglyphics we are enabled to do exactly the same thing with perfect definiteness, by considering the wave length of the particular color with which we have to deal, so that, having these wave lengths, we may determine the quality of every kind of light which reaches the human eye, whether from a terrestrial light source, the sun or any other celestial body, including the shooting stars which some of us are hoping to see to-night.

Well, the result of the study of this hieroglyphic language has been that we can in that way determine the chemical source of every light of different color which can be thus examined in any celestial body, provided always we can obtain the same light note from some terrestrial substance when we experiment upon them at temperatures high enough to set them glowing in our laboratories. We can determine, therefore, by such means, whether in different parts of space we have the same chemical substance, or whether in different stars we are dealing with substances perfectly and completely distinct.

Imagine these hieroglyphics, then, more or less translated, on the principle I have indicated to you, by the labors of Kepler, Newton, Fraunhofer, and other later workers, so that in the case of anything shining anywhere, we can eventually find out something about its chemical and its physical constitution.

Another part of the prologue, before I begin my first chapter, brings us to another line of study, that is to say, the telescopic and visual observations of heavenly bodies.

I take you back to the year 1706, when there was a total eclipse of the sun, visible in Switzerland, and there was one Stannyan, who gave an account of what he saw at Berne. After describing the phenomena of the eclipse he wrote, referring to the sun: "His getting out of his eclipse was preceded by a blood red streak of light." Of course, in the prephotographic days no autobiographical record of that particular eclipse was obtainable, but we possess photographic records of other similar later eclipses, which may be taken as representing what Stannyan saw, for, in all, the blood red streak referred to by him has been seen.

The phenomena photographed in all eclipses nowadays indicate to us Stannyan's observation, for, in all, certainly the sun, in getting out of his eclipse, is preceded by a blood red streak of light, which we now know to represent one of the solar envelopes to which I gave the name of chromosphere in 1868.

Here then ends the prologue and I begin the first chapter of my story.

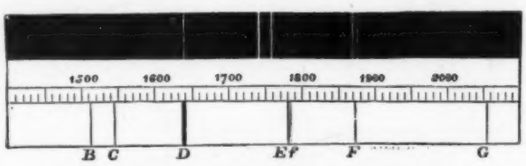


FIG. 1.—Pogson's diagram of the spectra of the sun's surroundings in the eclipse of 1868. The bright lines seen are shown in the upper part of the diagram; the chief lines in the solar spectrum, red to the left, blue to the right, are shown in the lower part.

CHAPTER I.

In the year 1868, the new alphabet to which I have referred was first utilized in endeavoring to unravel the message which was conveyed to us by a most interesting eclipse observed in India. The "blood red streak" was now subjected to minute analysis, because practically the spectroscope was now first utilized. The diagrams will indicate the kind of record with which we have to deal in studying these celestial hieroglyphics.

We are in one part dealing with the long waves of light, the red; we are in the other dealing with the shorter waves of light, the blue. The work done in that eclipse is indicated by the bright lines—the hieroglyphics—which, when translated as they have been, describe for us the chemical nature of the particular stuff in the sun, which made him put on a blood red appearance "on his getting out of his eclipse." Taking the notes in the light scale which are lettered in the ordinary spectrum of light, chiefly sunlight, in order that they may be easily recognized and remembered, we learn the particular qualities of the light emitted by the blood red streak.

We have one quality represented by the line, D, another at C, and another at F. Hence, the observers in 1868 could tell us very much more about the particular chemical substances which were present in that blood red streak than Stannyan could, because spectroscopy had not been invented in his day. According to the diagram (Fig. 1), one of the lines is in the position of D. One observer said it was "at D, or near D," and almost the whole of my story depends upon that distinction.

Soon after this eclipse was observed in India, a method, long before suggested, of studying the blood red streak surrounding the sun without waiting for an eclipse was brought into operation.

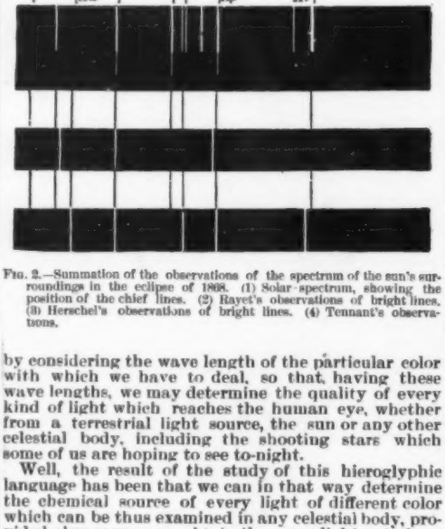


FIG. 2.—Summation of the observations of the spectrum of the sun's surroundings in the eclipse of 1868. (1) Solar spectrum, showing the position of the chief lines. (2) Hayet's observations of bright lines. (3) Herschel's observations of bright lines. (4) Tennant's observations.

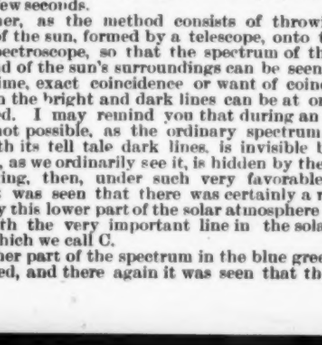


FIG. 3.—The exact coincidence of the red line with the dark line C, determined by the new method.

By this method it was quite easy to make observations, whenever the sun was shining, perfectly free from any of the difficulties attending the hurry and the worry and the excitement of an eclipse, which lasts only a few seconds.

Further, as the method consists of throwing an image of the sun, formed by a telescope, onto the slit of a spectroscope, so that the spectrum of the sun's edge and of the sun's surroundings can be seen at the same time, exact coincidence or want of coincidence between the bright and dark lines can be at once determined. I may remind you that during an eclipse this is not possible, as the ordinary spectrum of the sun, with its tell tale dark lines, is invisible because the sun, as we ordinarily see it, is hidden by the moon.

Working, then, under such very favorable conditions, it was seen that there was certainly a red line given by this lower part of the solar atmosphere coincident with the very important line in the solar spectrum which we call C.

Another part of the spectrum in the blue green was examined, and there again it was seen that the parts

* Presidential address before the Vesey Club, Sutton Coldfield, by Prof. J. Norman Lockyer, C.B., F.R.S.—From Nature.

outside the sun gave us a bright line exactly in the position of the obvious dark line in the solar spectrum which is called F, so that with regard to those two most important lines, there was no doubt whatever that we were dealing with the substance which produces these dark lines in the solar spectrum.

Fig. 5 is a diagram of the yellow, or rather the orange, part of the solar spectrum, showing two very important lines, which are called the lines, D, due to the metal sodium, the investigation of which was just as important in solving these celestial hieroglyphics as the Rosetta stone was important in settling the question of the Egyptian ones.

Pogson, in referring to the eclipse of 1868, said that the yellow line was "at D, or near D." You will see

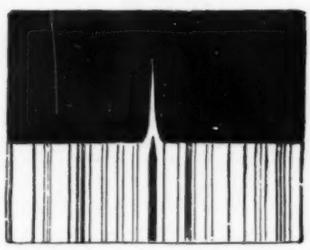


FIG. 4.—The exact coincidence of the blue-green line with the dark line F.

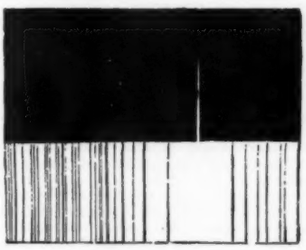


FIG. 5.—The want of coincidence of the range line, D^3, with the dark lines D^1 and D^2.

from this diagram that the new method indicated that "near D" was the true definition. The line in this position in the spectrum, unlike the other two lines which I have indicated, has no connection at all with any of the dark lines in the ordinary solar spectrum. We were, therefore, perfectly justified in attaching considerable importance to this divergence in the behavior of this line, taking the normal behavior to be represented by the two strong lines in the red and the blue green. The new line was called D^3 to distinguish it from the sodium lines, D^1 and D^2.

A considerable amount of work was done with regard to the yellow line. It was found that there was no substance in our laboratories which could produce it for us, whereas in the case of the line, D, we simply had to burn some sodium, or even common salt, in a flame to produce it, and the other lines in the red and

A B C

FIG. 6.—Changes of wave length of the F hydrogen line when a solar cyclone is observed. A, the change toward the red indicates the retreating side of cyclone. C, the change toward the blue indicates the advancing side. B, the whole cyclone is included in the width of the slit, and both changes of wave length are visible.

the blue green were easily made manifest by just inclosing hydrogen in a vacuum tube and passing an electric current through it, or observing the spectrum of a spark in a stream of coal gas.

Now at the first blush it looked very much as if this line was really due to the same element which produced the others at C and F, and it was imagined that the reason we did not see it in our laboratories was because it was a line which required a very considerable thickness of hydrogen to render it visible. That was the first idea, and Dr. Frankland and myself found that there was very considerable justification for this view, because a simple calculation showed that the thickness of the solar atmosphere, which was produce-

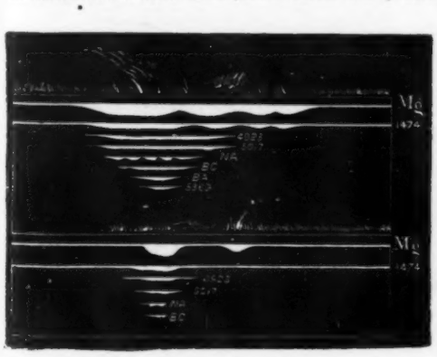


FIG. 7.—Tacchini's observations of two slight solar disturbances showing the height to which the layers of the different gases extend. Magnesium vapor is highest of all, and is furthest extended; next comes a gas of still unknown origin, indicated by a line at 1474 of Kirchhoff's scale, and so on.

ing that yellow line under the conditions which enabled us to see it in our instruments by looking along the edge of the sun, was something like 200,000 miles.

Hence in order to get a final decision on this point there was nothing for it but to tackle the question from a perfectly different point of view, and the different point of view was this. The work had not gone on very long before one found minute alterations in the positions of these lines in the spectrum; the blue line, for instance, might sometimes be slightly on one side, and sometimes on the other of its normal position. Further work showed that in these so-called "changes of wave length" we had a precious means of determining the rate of movement of the gases and vapors in the solar atmosphere.

Fig. 6 indicates how these changes of wave length are shown in the spectroscope. The lines are contorted in both directions, and sometimes to a very considerable extent, indicating wind movements on the sun, reaching, and sometimes exceeding, 100 miles a second!

Well, then, you see we had here a means of determining whether the yellow line was produced by the same gases which gave the red and blue lines, because, if so, when we got any alteration in the position of the red and blue lines, which always worked together, we should get an equivalent alteration in the position of the yellow one.

I found that the yellow line behaved quite differently from either the red or the blue line; so then we knew that we were not dealing with hydrogen; hence we had to do with an element which we could not get in our laboratories, and therefore I took upon myself the responsibility of coining the word helium, in the first instance for laboratory use.

This kind of work went on for a considerable time, and what one found was, that very often in solar disturbances we certainly were dealing with some of the lines of substances with which we are familiar on this earth; but at the same time it was very remarkable that when the records came to be examined, as they ultimately were with infinite care and skill, it was found that not only did we get this line in the yellow indicating an unknown element associated with substances very well known, like magnesium, but that there were many other unknown lines as well. Within a few months of my first observations, several new lines about which nothing was known were thus observed. The place of this orange line I determined on October 20, 1868. Among many other lines behaving like it, two at wave lengths 4923 and 5017 were discovered in June, 1869, and afterward another at 6677, while Prof. Young noted another in September, 1869, at 4471. He wrote:

"I desire to call special attention to 2581·5 [Kirchhoff's scale], the only one of my list, by the way, which is not given on Mr. Lockyer's. This line, which was conspicuous at the eclipse of 1869, seems to be always present in the spectrum of the chromosphere. . . . . It has no corresponding dark line in the ordinary solar spectrum, and not improbably may be due to the same substance that produces D^3."

This same line was noted also by Lorenzoni, and named f.

Then with regard to solar disturbances. Let me refer in detail to a diagram indicating some results arrived at by the Italian observers. We are dealing with the spectroscopic record of two slight disturbances in a particular part of the sun's atmosphere. The spectroscope told us that in that region there was a quantity of the vapor of magnesium which was collected in that place. Then we find that another substance, about which we again know nothing whatever, is also visible in that region, and then we get the further fact that in those particular disturbances we get four other spectral lines indicated as being disturbed, and of those four lines we only know about one.

In this way it very soon became perfectly clear to those who were working at the sun, that in all these disturbances, or at all events in most of them, we were dealing to a large extent with lines not seen in our laboratories when dealing with terrestrial substances; this work went on till ultimately, thanks to the labors of Prof. Young in America, we had a considerable list of lines coming from known and unknown substances which had been observed under these conditions in the solar chromosphere, and Prof. Young was enabled to indicate the relative number of times these lines were visible. For instance, the lines which are most frequently seen under these conditions he indicated as represented by the number 100, and of course the line which was least frequently seen would be represented by 1; and therefore from these socalled "frequencies" we got a good idea of the number of times we might expect to see any of these disturbance lines, when anything was going on in the sun.

It was this kind of work which made Tennyson write those very beautiful lines:

"Science reaches forth her arms
To feel from world to world."

And then he added:

"and charms
Her secret from the latest moon."

I mention this because Tennyson, whose mind was saturated with astronomy, had already grasped the fact that what had already been done was a small matter compared with what the spectroscope could do; and now the prophecy is already fulfilled, for by means of the spectroscopic examination of the light from the stars we can tell that some of them are double stars, that is to say, in poetic language, stars with attendant moons. Although we can thus charm the secret from each moon by means of the spectroscope, to see the moon it would require a telescope not 80 ft. long, but with an object glass 80 ft. in diameter, because the closer two stars are together the greater must be the diameter of the object glass independently of its focal length and magnifying power.

(To be continued.)

DE ROCHAS' EXPERIMENTS ON HYPNOTISM.*

FEW of our modern attempts to solve scientifically the great mystery of life have led us to more astonishing results than the discoveries made recently in Paris by Col. A. De Rochas, the well known scientist and director of the Ecole Polytechnique, concerning the "luminous effluvia," or magnetic emanations, from the bodies of living men. For the benefit of such readers as may not be familiar with previous discoveries, the knowledge of which is necessary in order to understand the recent investigations of Col. De Rochas, I must translate first here some statements of a celebrated Austrian chemist, the Baron von Reichenbach, who was the first scientist, over forty years ago, who discovered the "luminous effluvia," or phosphorescent-like emanations from animals, plants and magnets.

Here are Reichenbach's own words ("Lettres Odiques et Magnetiques," Stuttgart, 1856):

Take a "sensitive" man and put him in a dark room. Take along a cat, a bird, a butterfly, if you have one, or only some flowerpots. After a few hours of such a sitting in the dark, you will hear that man say some very strange things. The flowerpots will appear to him in the darkness and become perceptible. At first they will appear as a gray cloud on a black background, then he will see some lighter spots; finally each flower will become distinct, and all forms will appear more and more clearly. Your cat, your bird, your butterfly, will all appear thus in the dark, and some parts of these animals will appear luminous. Then your sensitive man will tell you that he sees you. Tell him to look at your hands. At first he will say that he sees a gray smoke: then the fingers will appear with their own light. He will see a luminous protuberance at each finger, sometimes as long as the finger itself. You will then probably hear him say with much surprise that the colors of the light are not the same in all parts of the body; that the right hand shows a blue light, and the left hand a yellow reddish light; that the same difference appears at your feet; and also that all the right side of your body and face is bluish and darker than the left side, which is ye'low reddish and much lighter (Letter 5).

Reichenbach found something else. He discovered that under similar conditions in a dark room a magnet emits a blue light at its north pole and a yellow reddish light at the south pole. This light varied, according to the strength of the magnet and the sensitiveness of the seer, from one to three feet in diameter. It appeared like a fiery flow intermingled with sparks. Reichenbach's experiments were repeated in England by Alfred Russel Wallace, Gregory, and other prominent naturalists, and were fully confirmed. It is only recently that Reichenbach's discovery was taken out of oblivion by Dr. Durville, Dr. Luys, and Col. De Rochas, with what extraordinary results we shall now see.

Col. De Rochas hypnotized at different stages two different subjects at the same time and in the same room. Let us call them A and B. A reported that he could see a luminous or phosphorescent coating on B's body; he could see besides that B's eyes, mouth, ears, nostrils, and finger ends were emitting a flamelike light, blue on one side of the body, yellow reddish on the other. A common glass of water being brought, it was put within the radius of B's luminous effluvia as described by A, who could see how far they reached. After a few minutes A reports that the water itself has become luminous, and that it remains luminous for a long while, even if removed to the other end of the room out of reach of B's effluvia. B's sensitiveness of the skin has been made to disappear by the hypnotic process; but any touch or puncture of a pin or needle on the outside edge of the phosphorescent or luminous coating perceived by A's eyes is immediately perceived by B. His body does not feel the sharpness of a needle, but the outer edge of his luminous effluvia, several feet away from the skin, has acquired that sensitiveness lost by the body. And here appears a wonderful fact. The water in the tumbler removed to the end of the room has acquired that same sensitiveness. If you pinch the water with your fingers or touch it with a pin, B will scream that you pinch him or prick him with a pin. But B will not feel the action if performed by a person who has no magnetic relation to him; in other words, the action of the magnetizer alone will be felt in the water by the subject.

Let us examine now more closely and with more details this strange transfer of the sensitiveness of our nerves to inert objects, which Col. De Rochas calls the "exteriorization of sensitiveness." A's eyes have been brought up by hypnotic process to a state which allows him to see the "luminous effluvia." But what he sees and describes varies a great deal, according to the grade of hypnotic sleep in which B is being plunged. When B is awake and in his normal state, A describes the "effluvia" as a luminous coating on the skin; but as soon as B loses his sensitiveness under the action of mesmerism, the coating seems to dissolve itself in the atmosphere. Then it reappears like a light mist or smoke, which condenses itself and be-

* Henry Gaullieur, in the Arena, Boston.

comes brighter and brighter, till it takes again the appearance of a thin coating of light following all the forms of the body at a distance of about an inch from the skin. B feels then every touch of the magnetizer on the surface of that coating.

If you continue the hynotizing process on B, A will see, around B's body, several new luminous coatings separated one from the other by a space of about two inches. The sensitiveness of B exists then only on these coatings of light, and seems to be in inverse ratio to their distance from the skin. These coatings will extend from six to nine feet from the body. They will go through a wall, not being stopped by masonry; and they will appear in the next room through the wall. Now if we make a small statuette or figure of common moulding wax and place it awhile in the "luminous effluvia" of B, then withdraw it and prick it with a pin, B will feel the puncture of the pin at the corresponding part of his body. If you cut a lock of his hair during his sleep without his knowledge, then plant that lock of hair on the wax figure and pull it slightly, B exclaims suddenly, "Who is pulling my hair?" The same results are obtained if you try the experiment with the whiskers or beard, or even sometimes with the trimming of a fingernail. Generally in most cases reported by Col. De Rochas the sensitiveness did not extend over 15 or 20 feet from the body of the subject, but there were exceptions.

The sensitiveness was then transmitted to a photographic image of the subject by leaving the plate for some time before using it in the "effluvia" of the subject. Here in several instances the plate retained the sensitiveness of the latter for several days. But unless the sensitiveness of the subject has been exteriorized (transferred from the skin to the "effluvia") before the photograph is taken, and unless the plate has been well impregnated in the "effluvia," the sensitiveness does not exist. Col. De Rochas tells us that he made the following experiment on Mme. O——. He used generally the palm of his right hand to hypnotize her; he had a life-size photograph of that palm of his hand taken. Mme. O—— was awake and sitting on a chair, not knowing what was going on in the room. Then one of the assistants, being concealed behind a screen, presented the plate on which the hand of Col. De Rochas was photographed to the plate on which the image of Mme. O—— had been previously taken. At the instant when the gentleman opposed the two plates to each other, Mme. O—— stopped her talk and fell asleep on the chair. Then Col. De Rochas walked behind the screen and woke up Mme. O—— by simply blowing on her image.

The sense of touch or feeling seemed to be the only one exteriorized. It should also be observed that all these experiments succeeded only with persons whose sensitiveness was either naturally very great or whose sensitiveness became developed by practice. Thus, this wonderful "exteriorization" and transfer of a man's sense of feeling to inanimate objects opens now a vast field for new investigations. It shows, in the first place, what enormous physical influence on health and disease the luminous effluvia of a human being can exert. Then again this transfer of sensitiveness to inert objects throws a most interesting light on the dark and obscure practices of sorcerers and witches in the middle ages. Our forefathers believed in the faculty of hurting an enemy under peculiar conditions prescribed by sorcerers, by transferring to him a disease or by stinging his image duly prepared for the purpose. Then again these facts recently discovered in Paris by De Rochas, and others, who followed and repeated his experiments shows conclusively—in the writer's opinion at least—that the common scientific theory based on our present knowledge of matter by which we have tried to explain man's nature is absurd.

INVESTIGATIONS ON ROENTGEN RAYS.*

I HAVE the pleasure to communicate briefly to this academy the results of some investigations I have made on the Roentgen rays.

The theoretical part of these investigations aims at determining whether the rays are a form of light, in the sense of being vibrations in the ether; it is known that Roentgen, in his memoir, suggests that they are longitudinal waves in the ether. However, on reading Roentgen's paper, I concluded from the facts he had established, and more especially from the fact that the rays were propagated with the same velocity in different transparent media, and that a body is more transparent the less its density, that the rays might be considered as highly rarefied matter projected from the Crookes tube, matter to which lighter bodies would be more permeable. Bodies would be traversed more or less easily by the small particles, in the same way that a sieve more or less fine would be by a stream of small shot. This suggestion I had mentioned privately, and was, unknown to me, reported in a correspondence in a political journal.

From a short account of the conference held at Pisa, by Prof. Garbasso, I gathered that this idea was shared by him and the well-known savant Battelli, and that their researches on the subject tended to confirm it. At that time I had already made experiments in the same direction. Till now all attempts to discover if bodies transparent to the Roentgen rays show any phenomena analogous to the different colors of ordinary light have yielded negative results. Not having, however, at my disposal a sufficient number of metals in thin sheets, I cannot state definitely that such a color effect does not exist. The absence of any such effect would, when more fully established, certainly speak in favor of the hypothesis I suggested above—that of rarefied matter projected from the tube. Of what nature could this matter be? Evidently, either ordinary matter—that constituting the Crookes tube (the glass, electrodes, or gas in the tube); or an imponderable matter—the ether. If it were ordinary matter projected from or through the Crookes tube, it appears probable that it could be electrified. Powerful electrostatic charges should then deviate the rays. I have started some experiments with the view of testing this, but have encountered difficulties which I shall probably be unable to overcome with the few appliances at my disposal. I shall make known to the academy any results I may obtain.

I shall now speak of my endeavors to facilitate the applications of Roentgen's discovery.

First, I have the honor of laying before the academy some photographs taken by the well-known method indicated by Roentgen; for, besides being excellent photographs, they show some new features. The photographs are:

1. Those of various metals (magnesium, aluminum, iron, lead, zinc, copper, palladium, silver, gold, and platinum) photographed together on the same plate. They confirm the relation found by Roentgen between the transparency and density.

2. Photographs of the same metals, and, further, a scale of transparency, obtained by photographing the shadow of a thin rectangular slab of aluminum having one side tapered. These photographs are those I took in seeking for a possible color effect, placing between the Crookes tube and the metal sheets various substances, such as cardboard, aluminum, sheets of gold and silver, etc. In spite of these being interposed, the photographs, when compared with the scale of transparency, show the same relative intensity.

3. A photograph of the shadow of my hand. This kind of picture shows, as is well known, the bones, and not only the phalanges of the fingers, but also the whole metacarpus is seen. It is noticeable that the cartilages are far less transparent than they appear in the pictures published in the journals, and, on the contrary, the spongy parts of the phalanges are more transparent.

4. A photograph of the shadow of the œdematous hand of a corpse (that of a woman aged fifty-nine); in the second phalange of the index finger was fixed an iron nail; that of the middle finger was broken by a hammer; in that of the third was introduced a small drop of mercury; finally, the palm of the hand was pierced with a needle, which was entirely hidden in the flesh. In the photograph these details are all clearly shown. Besides all the phalanges of the fingers and the metacarpus, which are clearly visible with all the joints, the carpus can just be distinguished. Here also may be noticed that the cartilages are not very transparent, and the spongy parts of the phalanges show up well.

5. A photograph of the same hand; besides the phalanges of the fingers and metacarpus, may be seen clearly defined the small bones of the carpus, with their details, and further, the portion photographed of the radius and the cubitus. The peculiarities shown by the cartilages and spongy parts are repeated also in this example.

6. Two photographs of an artificially paralyzed frog, taken with very different exposures. I would call attention to one point—not hitherto noticed, as far as I know—which may interest this Academy of Medicine; in one of these photographs may be seen, besides the bone structure, the two lungs; in the other, besides the lungs, the heart, and another internal organ, which I conclude is the spleen. As might be expected, the lungs appear the more transparent.

I shall now relate the observations I have made by eye.

First I propose to consider the reason that the human eye is not directly sensitive to the Roentgen rays. A priori, there is no impossibility in these rays exciting a luminous sensation. The phenomenon of persistence of vision with ordinary light may be attributed to a fluorescence of the retina or optical system of the eye. Now, Roentgen has found that to a certain extent bodies fluorescent to ordinary light are so also to his rays. Were this the case with the retina, it is obvious that the rays could give a luminous sensation, since they would produce actual light on the retina. With this idea I made some experiments on a retina taken from the eye of a living rabbit. Observations made with this living retina showed that, while somewhat fluorescent to the direct light issuing from a Crookes tube, it gave no indication of fluorescence with the Roentgen rays. I should mention, however, that my two observations are not sufficient absolutely to exclude such a property from the living retina, as the phenomena shown by the Crookes tube, with which I have hitherto worked, are not very intense.

I next examined photographically the transparency to Roentgen rays of the crystalline lens of the eye, and I obtained the result that the lens, together with the various media forming the optical system of the eye, intercepts the rays to approximately the same extent as a sheet of glass one millimeter thick; that is to say, they are only slightly transparent. Trials of the separate portions of the eye showed that the crystalline lens was the most opaque part, while the cornea was the most transparent. The conclusion I derive from these results is that, though the retina may be fluorescent to the Roentgen rays, as is the glass of the photographic plate, it is hardly probable that it could see objects directly through layers of wood, aluminum, flesh, etc. This, however, does not exclude the possibility of seeing them indirectly, by transforming, so to say, the Roentgen rays into ordinary luminous rays before they reach the eye. I have made a simple arrangement by means of which I can distinctly see the shapes of bodies inclosed in boxes of cardboard, aluminum, etc. This cryptoscope, which I have the honor of showing to the academy, consists of a small cardboard tube about eight centimeters high. One end is closed by a sheet of black paper, on which is spread a layer of fish glue and calcium sulphide (there being no barium and platinum cyanide at hand); this substance I have found to be very phosphorescent under the action of Roentgen rays. Within the cardboard tube, at the other end, at which the eye is placed, is fixed a lens, giving a clear image of the phosphorescent paper.

On looking through this cryptoscope one can see, even in a light room, the shape and position of metallic bodies inclosed in boxes of cardboard, wood, aluminum, and within the flesh. Its action is obvious; the fluorescent paper under the action of the rays is illuminated only in those portions which receive rays; consequently the silhouettes of the objects intercepting the rays appear dark. In this there is, of course, nothing new which could not have been deduced from the original experiments of Roentgen; the novelty, if, indeed, it is so, consists merely in making use of the known facts to design the arrangement. It seems to me that, in a more perfected form, it might be of extensive use in surgical and medical science. The sulphide of calcium may be replaced with advantage by the cyanide of barium and platinum. It is further clear that when, by a camera or other means, not only the shadows, but also the images can be photographed (which, I believe, Profs. Battelli and Garbasso, of Pisa, have already succeeded in doing) the same cryptoscope will render visible also the images of bodies inclosed in boxes of wood or other materials.

As soon as possible I shall communicate the results of experiments I have begun with the view of shortening the necessary exposure by means of sensitive plates containing phosphorescent substances, or sensitive films backed by phosphorescent papers.

Finally, I wish to offer my warmest thanks to my honored colleague, G. Pisenti, professor of pathology, and rector of the university, who has given me every possible assistance, and himself prepared the various portions of the eye with which I made the experiments.

* By Prof. E. Salvioni. Translated from the Proceedings of the Accademia Medico-Chirurgica di Perugia, vol. viii, No. 1-2.—From Nature.

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